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Atlantic Salmon Culture in Puget Sound

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On the cover: Atlantic salmon photographs courtesy of the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, NOAA.

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Culture of Atlantic Salmon, *Salmo salar*, in Puget Sound

JAMES L. MIGHELL

Introduction

Depletion of the Atlantic salmon, *Salmo salar*, from lakes and streams in New England began in colonial times and increased as industrialization intensified (Netboy, 1968). Obstructing dams, siltation due to lumbering and sawmill activities, industrial pollution, and uncontrolled fishing led to the disappearance of salmon from most of the region.

Abatement of pollution and construction of fishways around dams were begun in attempts to return streams to habitable conditions and restore salmon runs to their earlier abundance. To restock the streams and reestablish the species' complete life cycle, a source of eggs is necessary. This could be provided by adult spawners (or a brood stock).

ABSTRACT—Atlantic salmon, Salmo salar, *stocks are extremely low in New England streams. A pilot study conducted in Puget Sound, Wash., showed that Atlantic salmon brood stock could be reared successfully by combining special techniques of fry rearing and saltwater pen culture as used for Pacific salmon. Fingerlings smolted at 13-15 months of age and first adult spawning occurred at 4 years of age. Smolt size varied in different groups from an average weight of 19.6-200 g (0.70-7.0 ounces). The 1971 and 1974 brood Atlantic salmon spawned for the first time at 4 years of age, when they were averaging about 4.0 kg (8.8 pounds) and 4.2 kg (9.4 pounds), respectively. Survival of the 1971 and 1974 broods in salt water from smolt to mature adult was 90.3 and 81.1 percent, respectively. The egg survival through hatching was 82.7 and 71.4 percent, respectively.*

In 1971, National Marine Fisheries Service (NMFS) scientists in the agency's Northeast Regional Office proposed a feasibility study and pilot test in the Pacific Northwest (Puget Sound, Wash.) to rear Atlantic salmon from the egg to spawning stage to produce eggs for subsequent shipment to New England hatcheries. A total rearing system, using net-pen culture in salt water, would make it possible to establish sufficient brood stock from virtually any stock desired.

The advantages of raising these fish in the Pacific Northwest rather than New England are: 1) Sheltered waters of Puget Sound, 2) mild climate, and 3) surface water temperatures ranging from 6° to 16°C each year as opposed to much colder winter temperatures and warmer summer temperatures on the New England coast (Colton and Stoddard, 1972).

Saltwater culture systems appear to be a good technique for raising a brood stock of selected species. Saltwater systems for raising captive Atlantic salmon brood stock are successful in both Norway and Scotland[1,2].

Coho salmon, *Oncorhynchus kisutch*, have been reared in a pilot brood stock rearing study at the NMFS Northwest and Alaska Fisheries Center's Manchester Marine Experimental Station, Manchester, Wash., which specializes in aquaculture research. Using net pen rearing techniques similar to those used for commercial production of marketable pan-size Pacific salmon (*Oncorhynchus* spp.), broodstock coho salmon were successfully reared to maturity in their second or third year of age. Survival ranged from 5 to 85 percent of the eggs produced by individual females (Novotny, 1975).

The specific objectives of the Atlantic salmon pilot study were to: 1) Establish a successful methodology for rearing Atlantic salmon smolts; 2) determine growth rate and survival of smolts reared to maturity in saltwater net pens; 3) determine relative resistance of Atlantic salmon to disease organisms indigenous to Pacific Northwest waters; and 4) establish maturation schedules, fecundity, and fertility of adult female Atlantic salmon reared to maturity in saltwater net pens.

Atlantic salmon needed to initiate the study were obtained from the Wizard Falls Hatchery of the Oregon Department of Fish and Wildlife (ODFW) as parr (1971 brood) or eyed eggs (1972 and 1974 broods). The Wizard Falls Hatchery stocks are the progeny of parents that were 6-10 generations removed from anadromous salmon from the Gaspé Peninsula in Quebec, Canada, near the entrance to the St. Lawrence River. Although this was strictly a pilot test, the stock used was considered typical of the New England region.

Fish from the 1975 brood, used only

[1]Lecture at the University of Washington, Seattle, on "Atlantic Salmon in Norway" by Magnus Berg, 24 November 1972.

[2]Needham, E. A. The salmonid pathologist in 1977. *In* Proceedings from the International Symposium on Diseases of Cultured Salmonids, April 4-6, 1977, Seattle, Wash., p. 8-15. Tavolek, Inc., Seattle, Wash.

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for fry-to-smolt growth and seawater adaptation information, weie obtained from eggs of the first spawning of adults from the Manchester net pens.

Pilot Study Systems

For the Atlantic salmon brood stock program to succeed, it was necessary to establish successful techniques for handling the sequential changes from the egg stage through the spawning of the adult fish.

Incubation

Heath[3] incubators were used to incubate the eggs to hatching. Heath incubators and small shallow troughs with or without gravel substrate in the presence or absence of light were used for incubation of alevins to the swim-up or initial feeding stage. Incubation of the alevins in different environments produced fry of various sizes as indicated in Table 1. The two dark environments produced the heaviest fry which consequently elicited the superior feeding response in comparison with fry incubated in a lighted environment. Research on other salmonids has indicated that fry quality can be enhanced by incubating the alevins on gravel or artificial substrates[4] (Bams, 1973).

Freshwater Rearing

Fresh water, used for rearing the Atlantic salmon from fry to smolt stage, was maintained at saturation levels for oxygen. Ammonia nitrogen was held below 0.1 ppm by adjusting water volume, and pH was 6.8 to 7.2. Artificial fluorescent lighting was controlled to simulate a natural photoperiod regime.

Rearing tanks were cleaned daily. The Oregon Moist Pellet (OMP), standard diet for artificial rearing of Pacific salmon, *Oncorhynchus* spp., was used throughout the freshwater rearing.

Exacting culture techniques in the early rearing stages are critical for success in rearing Atlantic salmon.

Table 1.—Feeding response of Atlantic salmon fry incubated in four different conditions of light and substrate.

Brood year	Lot	Incubator type	Lighting	Substrate	Mean length (mm)	Mean weight (g)	Condition index ($\frac{w \times 10{,}000}{L^3}$)	Feeding response
1974	1	Heath	Indirect	None	27.3	0.146	0.72	poor
1975	2	Heath	Dark	None	29.7	0.211	0.81	good
1974	3	Trough (4′ × 1′)	Dark	Gravel	27.1	0.226	1.1	exc.
1974	4	Trough (4′ × 1′)	Indirect	None	[1]	0.180	—	poor

[1] Length data incomplete, not included.

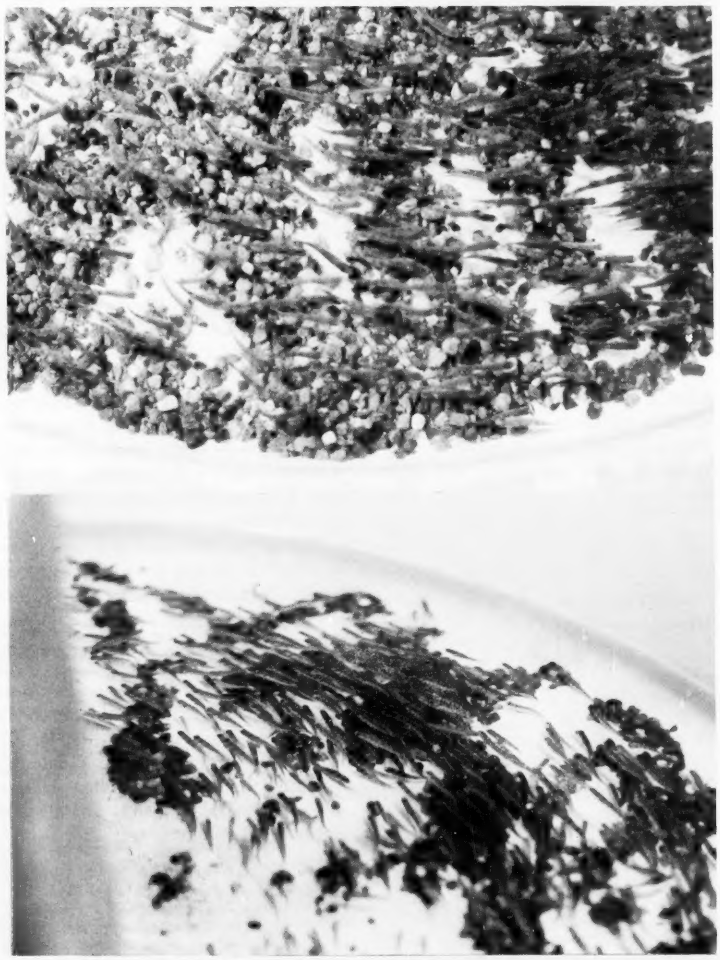

Figure 1.—Atlantic salmon fry in a circular tank with bottom substrate of pea-size gravel.

[3] Reference to trade names or commercial products does not impiy endorsement by the National Marine Fisheries Service, NOAA.

[4] Poon, D. C. 1977. Quality of salmon fry from gravel incubators. Auke Bay Lab., Northwest and Alaska Fish. Center, NMFS, NOAA, Auke Bay, Alaska. Unpubl. manuscr., 253 p.

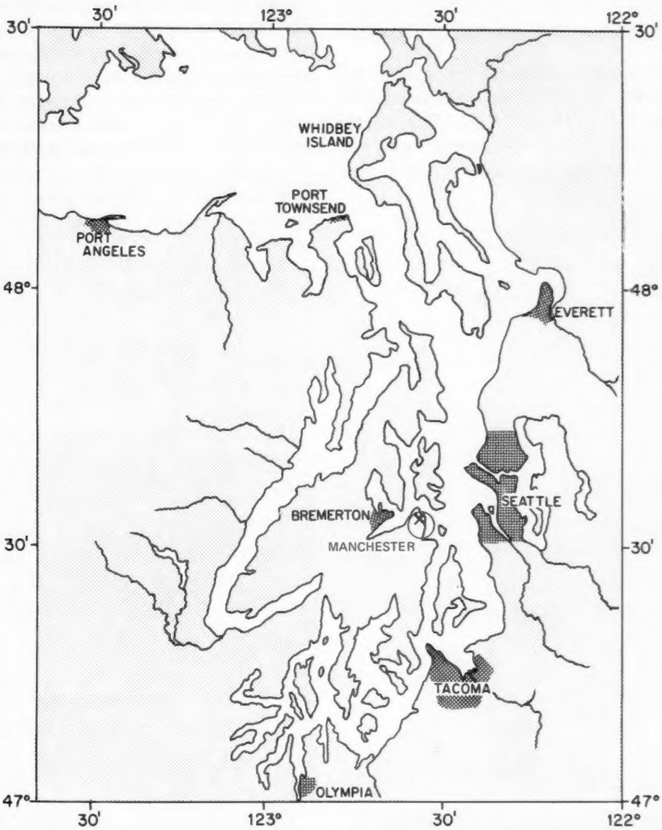

Figure 2.—Puget Sound, Wash., site of marine culture of Pacific salmon and pilot studies on Atlantic salmon at the NMFS Northwest and Alaska Fisheries Center, Manchester Marine Experimental Station (X), where aquaculture research is conducted.

After experimenting with many different rearing conditions, I found that the following conditions were most conducive to successful early rearing.

Circular Tanks

Circular tanks 1.2 m (4 feet) in diameter supplied with water moving at about 12-15 cm (0.4-0.5 feet) per second were nearly self cleaning and assured that the fish would continue to respond to artificial feeds (OMP). Even gravel-incubated fish responded poorly to artificial feeds when reared in straight troughs with water velocities from 3 to 15 cm (from 0.1 to 0.5 feet) per second.

Shallow Water

Newly emerged fry continued to respond well to artificial foods when kept at a depth of 5-10 cm (0.16-0.32 feet). At greater depths, the fry stayed on the bottom. When the fish reached a weight of 1 g (0.04 ounce), the water depth was increased to 30 cm (0.98 feet) with no adverse effects on feeding response.

Bottom Substrate

Simulation of natural stream bottom substrate was necessary to prevent crowding of fry near the outlet screen (Fig. 1). Substrates of gravel or dark gray painted blotches caused the fish to disperse evenly. Plastic materials have also been suggested to simulate a bottom substrate for Atlantic salmon fry (Leon, 1975).

Proper Loading Densities

A rearing density of 200 swim-up fry per 900 cm^2 (1 $foot^2$) of tank produced smolts with minimum loss. One-half that density (100 fish per 900 cm^2) was used once the fish reached a size of 7 g (0.25 ounce). Substantially higher or lower densities were detrimental to feeding response and at higher densities disease incidence was greater.

Water Temperatures of 12.4°-13.2°C

Temperatures elevated by 2°-5°C over ambient to about 12.4°-13.2°C were necessary to evoke a surface feeding response from newly emerged fry. This procedure was essential to successful rearing with the OMP diet. At lower temperature the fish remained on the bottom, and excessive food accumulated on the bottom resulting in increased disease.

Saltwater Rearing

Saltwater rearing from smolt to adult stage was done at the Manchester Marine Experimental Station (Fig. 2). There, waters are protected by the mainland on the south and Bainbridge Island on the north. Salinity ranged from 26 to 30‰, and biweekly mean temperature varied from 7.1° to 13.9°C (range from 6.6° to 15.4°C) (Fig. 3) during the experimental rearing period.

The Atlantic salmon smolts were transferred directly from fresh water to salt water and held in floating, knotless, nylon net pens 1.2 × 2.4 m (4 × 8 feet) and 2 m (6.5 feet) deep. As the fish grew, the net pen size was increased to an eventual size of 4.8 m (16 feet) on a side with a maximum depth of 3.7 m (12 feet). Mesh opening (hanging) varied from 0.6 cm (0.25 inch) at the outset to 2.5 cm (1 inch) for

adults. Commercial OMP diet was used throughout the saltwater rearing period with the exception of 10 percent supplemental feedings of crustaceans and whole anchovy or herring 2 months before spawning of the 1971 brood only. The fish were examined for growth and maturation on an intermittent basis (Fig. 4-7).

Results

Freshwater Growth and Survival

The optimum water temperature for growth of *Salmo* spp. is between 10° and 17°C (Huet, 1972). The winter temperatures of most natural fresh waters in North America decline to less than 7°C, whereas water temperatures during the summer may exceed 20°C. The result is that most Atlantic salmon from natural and artificial rearing environments of North America reach the smolting stage in their third spring (2+ years old). In many colder locations the smolt stage is not achieved until after 3+ years of rearing. Atlantic salmon must reach an approximate fork length of 10 cm (4 inches) near the end of the summer-fall growing season if they are to attain parr-smolt transformation in the spring (Elson, 1957); and for a variety of reasons, but primarily temperature, Atlantic salmon do not achieve the size at most rearing sites until the end of their second growing season.

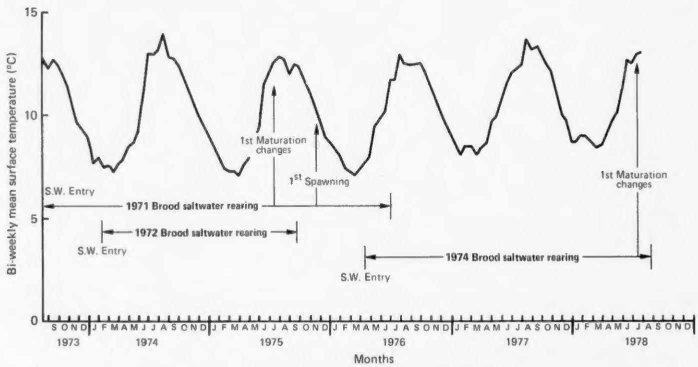

Figure 3.—Biweekly mean water temperatures during the saltwater rearing of 1971, 1972, 1974, and 1975 brood Atlantic salmon in Puget Sound, Wash.

Figure 4.—Net-pen reared Atlantic salmon, 2-5 kg (5.5-11.0 pounds), are crowded prior to removal for individual measuring.

However, Atlantic salmon smolts were produced in 13-15 months in Oregon when reared at a constant temperature of 10.5°C[5]. Likewise, in our growth trials we were able to produce yearling smolts using heated water ranging from 12.4° to 13.2°C (from 2° to 5°C over ambient) during fry rearing and temperatures ranging from 8° to 15°C for a substantial part of the remaining freshwater rearing period (Fig. 8). The smolts reared by NMFS from the 1972, 1974, and 1975 broods grew to mean weights of 22.6, 37.7, and 19.6 g (0.80, 1.33, and 0.70 ounces), respectively.

The much greater size achieved by the 1974 brood (Fig. 8) was at least in part due to their being reared in warmer water than the 1975 brood from the 18th to the 54th week after initial feedings. Total thermal units (T.U.) (1 T.U. = 1°C for 24 hours) accumulated were 4,600 and 4,100 for the 1974 and 1975 broods, respectively. The 1974 brood fry also emerged from gravel incubation at a greater average weight than the 1975 brood (Table 1). Growth of the 1972 brood was not plotted due to the lack of complete temperature data.

Survival of the experimental rearing lots in fresh water ranged from 0 to 86 percent. When the aforementioned rearing requirements were not met

[5]Morton, G. 1972. Oregon Dep. Fish. Wildl., Wizard Falls Hatchery, Sisters, Oreg. Pers. commun.

in their entirety, survival was less than 40 percent in every case. However, when all conditions were met during the rearing of the 1974 and 1975 broods, the survival was 86 and 73 percent, respectively.

Seawater Adaptation

Yearling Atlantic salmon smolts from the 1972, 1974, and 1975 broods entered salt water in February, March, and April, respectively (Fig. 9) at weights ranging from 19.6 to 37.7 g (from 0.70 to 1.33 ounces). All were transferred directly from fresh to salt water when they exhibited visual signs of smolting, i.e., loss of parr marks, silvery appearance, decrease in the condition index value, and black fringe on caudal and dorsal fins.

Each of the stocks transferred survived at a rate of 96 percent or more for 30 days after transfer. Only the 1975 brood, which had a substantial number of fish under 10 cm (4 inches) in fork length, showed significant incidence of parr reversal or nonadaptation to salt water. Reversal was in approximately the same percentage (24 percent) as the number of fish under 10 cm (4 inches) in length.

The 1971 brood smolts were obtained from the ODFW as large parr in the summer of 1972 and were held in fresh water until they were 18 months old or about 5 months past the normal smolting age. At the time of saltwater entry they ranged in weight from 150 to 260 g (from 5.3 to 9.2 ounces). All fish ($n = 31$) over 180 g (6.3 ounces) in weight ($\bar{x} = 200$ g or 7.0 ounces) survived the direct transfer to saltwater with no later

Figure 5.—A large adult Atlantic salmon is removed from the rearing pen for measurement.

Figure 6.—Adult Atlantic salmon in net pens at Manchester, Wash.

reversion to parr. Only one of the smolts less than 180 g (6.3 ounces) survived in salt water for more than 2 months. Thus, successful saltwater adaptation in this stock of Atlantic salmon took place over the entire late winter-spring smolting period when the fish had reached a size of 10 cm (4 inches) or greater. But, when the fish were held beyond the normal smolting period, perhaps beyond the summer solstice (21 June), a much greater fish size was necessary to assure survival.

Saltwater Growth and Survival

Saltwater growth was plotted on a T.U. basis because of the widely varied saltwater entry dates for each of the smolt groups (Fig. 9). On that basis the 1972, 1974, and 1975 broods, which all entered salt water at the peak of smolting as determined by visual cues, grew to a similar size after 4,000 T.U. Thus, as expected, the smaller smolts grew faster, negating the apparent advantage of growing larger smolts. However, the smallest smolts (1975 brood) had a relatively high rate of parr reversals (24 percent). Parr were not included in growth analysis.

Growth of the 1971, 1972, and 1974 broods between 200 and 1,000 g (7.0 and 35.2 ounces) in weight was accomplished with a similar number of T.U.'s (2,600-3,000). However, their growth after that size was apparently affected by factors other than temperature. During that period the 1974 brood grew to 3.4 kg (7.5 pounds) using only about half the number of T.U.'s (2,600) used by the 1971 brood.

The slower growth of the 1971 brood was unexpected since they began that growth segment during early summer when the sea temperature was increasing. On the other hand, the rapid growth of the 1974 brood took place in the fall and winter months.

In July 1975, the growth of the 1971 brood declined, coinciding with the onset of maturation. By late February of 1976, maturing fish had recovered, and in the spring and early summer of 1976 a growth surge of about 2.0 kg (4.4 pounds) per fish occurred, resulting in a mean weight of 6.7 kg (14.8 pounds) and an upper range of 9.0 kg (19.8 pounds). This growth surge was coincidental with a rise in temperature from 7° to 12°C (Fig. 3).

The loss of all 1971 and 1972 brood Atlantic salmon to poachers shortly after the last weighing on 10 June 1976 prevented complete evaluation of growth, survival, and maturity through 5 years of total age.

Survival of the 1971 brood Atlantic salmon from the time of entry in salt water to the total age of 4 years was

Figure 7. —Individual Atlantic salmon are 1) anesthetized, 2) measured, and 3) returned to net pens.

90.3 percent, while the 1974 brood survival after 24 months in salt water was 92.4 percent. Survival figures are not available for the 1972 and 1975 broods due to escape and animal predation. River otters, *Lutra canadensis*, were responsible for nearly complete losses of smolts—as many as 2,400 fish in a single night. Some of these smolts were eaten and others escaped through holes in the nets that had been torn by the otters.

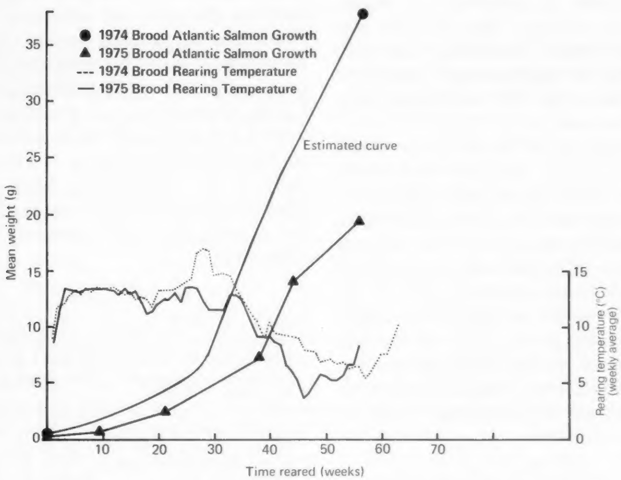

Figure 8.—Freshwater growth and rearing temperatures of Atlantic salmon reared at the Northwest and Alaska Fisheries Center, Seattle, Wash.

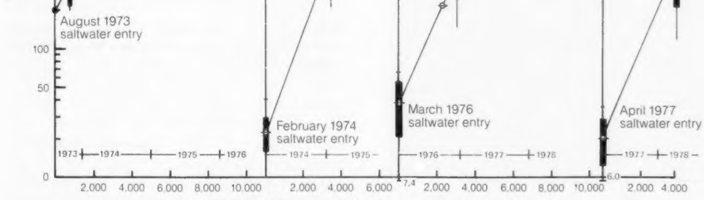

Figure 9.—Size range, mean, and standard deviation of Atlantic salmon reared in saltwater pens in Puget Sound, Wash.

Disease and Treatment

Resistance to endemic saltwater diseases of native Puget Sound fish was indicated by all of the Atlantic salmon groups reared at the Manchester site, with the exception of furunculosis, *Aeromonas salmonicida*. This disease was detected in the 1971 brood adults shortly before the first spawning 22 months after entry in salt water and in the 1975 brood smolts shortly after entry into salt water. The minor incidence of furunculosis in adult maturing fish was controlled by addition of the antibiotic chloramphenicol (Chloromycetin) at a level of 0.1 percent in the diet (Van Duijn, 1967). We have concluded that this treatment should be administered prophylactically at least 40 days prior to smolting and shortly before adult maturation.

Vibriosis, a saltwater bacterial disease common to Pacific salmon held in net pens in Puget Sound (Hodgins et al., 1977) and caused by *Vibrio anguillarum* was not a problem during our rearing of Atlantic salmon. To check for disease resistance, I purposely declined to vaccinate for vibriosis. The only detectable incidence of vibriosis occurred in the 1975 brood smolts shortly after entry in salt water and secondary to furunculosis. We observed that vibriosis is not a serious disease of the genus *Salmo*; cutthroat trout, *S. clarki*, and steelhead trout, *S. gairdneri*, both appear to have good natural immunity to the disease.

Minor occurrences of frayed fins and epidermal necrosis, typical symptoms of infections by myxobacterial organisms, were controlled with malachite green treatments at 1:19,000 concentration for 12 seconds and oxytetracycline (Terramycin) administered in the feed at the rate of 2 percent active ingredient for a period of 10 days.

Bacterial kidney disease (BKD), *Corynebacterium* sp., a previous problem with pen-reared brood stock of Pacific salmon[6], was not evident or

[6]Novotny, A. J. 1978. Manchester Marine Experimental Station, Northwest and Alaska Fisheries Center, NMFS, NOAA, Manchester, Wash. Pers. commun.

detected during routine etiological examinations of Atlantic salmon mortalities. Smolts of the 1971 brood were treated with the drug sulfasoxazole (Gantrisin) (10 g (0.35 ounces)/100 pounds of fish/day for 10 days) every 60 days prior to smolting as a prophylactic measure. None of the other broods were treated in any way to prevent BKD.

Sexual Maturation

Adults from the 1971, 1972, and 1974 broods matured in seawater. About 30-40 percent of the males matured at 3 years of age. However, no 3-year-old females matured. Both the 1971 and 1972 broods were progeny of 5-year-old parents (footnote 5), while the 1974 brood parents were 4 years of age.

Seven fish (4 males and 3 females) or 25 percent of the surviving 1971 brood fish (n = 28) matured at 4 years of age. We presumed that the remaining 75 percent would have matured in their fifth year with perhaps a few maturing in their sixth year. Two mature females were lost to osmoregulatory stress shortly before spawning, but a third female was successfully spawned with two males, producing 4,324 fertilized eggs. These eggs produced 3,580 hatched alevins (82.7 percent survival). The one female that was spawned had a fork length of 64.3 cm (25.3 inches) and a total weight of 3.4 kg (7.5 pounds). Postmortem examination of the other two mature females with fork lengths of 62.5 cm (24.6 inches) and 68.0 cm (26.8 inches) revealed 4,515 and 4,916 eggs, respectively.

Fifty females (72.5 percent of the 1974 brood adult females) matured at 4 years of age, indicating that age at maturity is influenced substantially by genetic factors. Forty-one of the females, averaging 4.1 kg (9.13 pounds) in weight, survived all aspects of handling. They produced an average of 5,625 eggs per female or 1,370/kg (616/pound) body weight and a total quantity of 230,650 eggs. The weight/fecundity relationship of the 1974 brood is shown in Figure 10.

The eggs of the three 1971 brood females appeared to be of excellent quality and were orange-red—possibly the result of the supplemental (10 percent of daily ration) feedings of fresh crustaceans and anchovy for 2 months prior to spawning. Eggs from the 1974 brood females, however, were pale yellow. No supplemental carotenoid was fed to the 1974 broodstock prior to maturation.

Of note is that the alevins produced from both the 1971 and 1974 brood adults did not develop pinched-off posterior portions of the yolk sac as noted by others working with this species (footnote 5) despite being incubated in a stock Heath incubator. All of the original lots we obtained from ODFW as eyed eggs produced alevins that had constricted yolk sacs during incubation, including those incubated in gravel. We have not yet determined the reason for this difference.

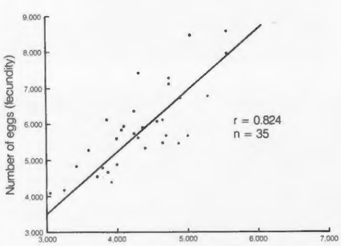

Figure 10.—Weight vs. fecundity relationship of 1974 brood Atlantic salmon reared to maturity in saltwater net pens in Puget Sound, Wash.

Conclusions

Atlantic salmon can be reared successfully in Pacific Northwest waters using techniques employed for rearing Pacific salmon, including the recently developed net pen culture systems in salt water. There appear to be no adverse factors in the rearing cycle that cannot be controlled with known fish cultural techniques. The mild temperatures in the area are conducive to production of yearling smolts. Saltwater rearing posed no particular difficulty; adult fish ranging from 2.5 to 5.0 kg (from 5.5 to 11.0 pounds) and from 5.1 to 9.0 kg (from 11.2 to 19.8 pounds) were produced at 4 and 4.6 years of age, respectively. Adult fish produced viable eggs and sperm; they had a subsequent hatch rate of over 80 percent.

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Guianas-Brazil Shrimp Fishery and Related U.S. Research Activity

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ABSTRACT—United States research activity in connection with the Guianas-Brazil shrimp fishery is described. The fishery's history is reviewed and catch and effort statistics are discussed. The fishery grounds extend from Trinidad south to the mouth of the Amazon River. Brown shrimp, Penaeus subtilis*; pink-spotted shrimp,* P. brasiliensis*; pink shrimp,* P. notialis*; and white shrimp,* P. schmitti*, compose the fishery. The analysis of catch statistics for all species combined for 1961-77 indicates that the overall catch has not increased parallel to the increase in fleet size, and that the total catch can be maintained at the 1978 level (15,000 t) or even increased slightly to a considerable increase in fleet size over the 1978 level (501 trawlers).*

Introduction

In the 1940's and 1950's, teams of explorers, sponsored by the Caribbean Commission, Surinam Government, and U.S. Government, located large aggregations of penaeid shrimp off the northeastern coast of South America. Based on the encouraging results of these surveys, a commercial shrimp trawling operation began in the late 1950's. With the United States and the Guianas first—followed by Trinidad, Brazil, and Barbados—Japan, Korea, Venezuela, and Cuba rushed (in the 1960's and 1970's) to grab a share of this newly discovered "gold mine," known as the Guianas-Brazil offshore shrimp fishery.

The Guianas-Brazil fishery grounds extend from Trinidad to south of the Amazon River (Fig. 1). Brown shrimp, *Penaeus subtilis*, pink-spotted shrimp, *P. brasiliensis*, pink shrimp, *P. notialis*, and white shrimp, *P. schmitti*, are harvested from these grounds. A combination of factors—open season, absence of territorial restrictions, a well-designed and rugged Florida-type shrimp trawler, inexpensive and abundant fuel, favorable market conditions, ambitious highly skilled fishermen, and cooperation by local governments—accelerated the development of this multimillion dollar fishery. Processing plants were erected in the ports of Paramaribo (Surinam), Cayenne and St. Laurent (both French Guiana), Georgetown (Guyana), Port of Spain (Trinidad), Bridgetown (Barbados), and Belem (Brazil). The shrimp processed and packed at these plants were exported primarily to the United States and Japan.

The number of trawlers and total landings for the period 1961-78 and the country where they are based are given in Table 1. The shrimp trawlers operating in this fishery consist chiefly of Florida-type trawlers, fairly modern and uniform in size, and are equipped with fishing gear and refrigeration systems. The vessels usually range from 70 to 75 feet (21.3-22.9 m) in length. These trawlers are usually rigged to fish two trawls, 40-55 feet (12.2-13.7 m) in length with 8-10 foot (2.4-3.0 m) doors.

The present U.S. fleet operates out of Cayenne, Paramaribo, and Georgetown. In earlier years our fleets also operated out of St. Laurent, Bridgetown, and Port of Spain. The numbers of U.S. boats from 1972 through 1978 are shown in Table 2.

The "good old days" in this restriction-free fishery began to crumble in 1970, as Brazil declared a 200-mile economic zone. To fish in Brazilian waters, from 1972 to 1978, foreign vessels were issued licenses under bilateral agreements. The first in the series of 2- and 1-year agreements was signed on 9 May 1972 between the United States and Brazil. The last

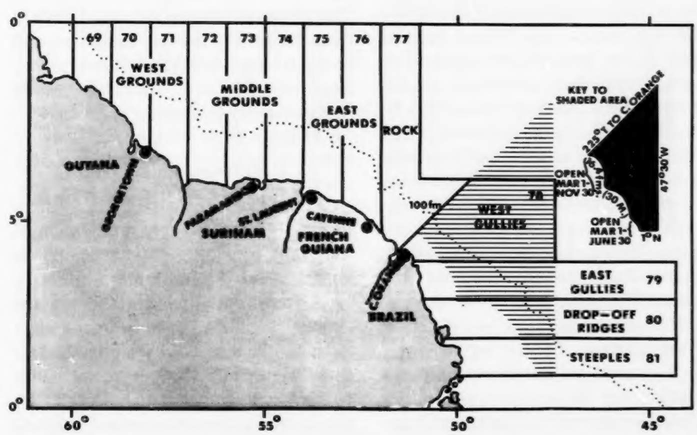


Figure 1.—The Guianas-Brazil shrimping grounds with fishing zones and their common names. The U.S. Agreement Area is shaded; the boundaries of the Area and the fishing seasons for U.S. vessels are shown in the inset.

Table 1.—Number of shrimp trawlers of various flag registries in the Guianas-Brazil fishery according to country where based. Cuban vessels operate with a mothership and use Guyana as a secondary base. Total landings are also given.

Year	Barbados	Trinidad	Venezuela	Guyana	Cuba	Surinam	French Guiana	Brazil	Total	Landings (t, whole weight)
1960	Data not available									2,785
1961	—	—	—	60	—	40	—	—	100	3,095
1962	—	—	—	72	—	24	—	—	96	4,371
1963	—	—	—	89	—	25	33	—	147	7,430
1964	30	—	—	81	—	25	51	—	187	9,262
1965	24	—	—	96	—	25	58	—	203	11,230
1966	32	43	—	105	—	34	67	—	281	15,475
1967	32	58	—	113	—	50	89	—	342	17,222
1968	35	48	—	134	—	55	90	—	362	19,259
1969	36	63	—	142	—	51	110	1	403	19,136
1970	25	78	—	162	—	55	83	18	421	19,081
1971	—	60	—	160	—	45	60	21	346	15,500
1972	—	55	—	175	—	55	60	25	370	16,126
1973	6	42	107	200	—	63	68	37	523	19,606
1974	21	39	66	202	10	106	62	55	561	17,687
1975	20	50	88	209	14	140	45	[1]25	591	15,567
1976	0	66	90	190	6	165	31	[1]38	586	16,753
1977	0	77	129	157	—	192	42	48	645	19,361
1978	0	—	58	148	—	165	78	52	501	15,188

[1] In 1975 and 1976 these vessels fished south of the Equator, outside the U.S.-Brazil Agreement Area.

Table 2.—Number of U.S. flag trawlers operating in the Guianas-Brazil shrimp fishery.

Year	Total no.	With UB no.[1]	Year	Total no.	With UB no.[1]
1972[2]	153	153	1976	134	99
1973	188	193	1977	141	90
1974	207	214	1978	122	—
1975	157	92	1979	Incomplete	

[1] UB number identifies boats that had licenses to fish the Agreement Area of Brazil (see Fig. 1).
[2] Half year.

bilateral fishing agreement between these countries expired on 31 December 1977. The number of fishing permits (Table 2) was limited and subjected to seasonal and other restrictions of the fishery in the Agreement Area (Fig. 1).

In 1977, Guyana, Surinam, and French Guiana initiated a licensing system parallel to the establishment of their extended national offshore fishing jurisdiction. Prior to the era of extended offshore fishing jurisdiction and licensing by Brazil and the Guianas, the geographic fishing pattern for most of the fleets was to fish Brazilian waters at the beginning of the year (up to May), then a gradual shift to French Guiana grounds (from May to July), and further shift to the grounds off Surinam (July-September) and Guyana (September-December). A portion of the fleet followed no pattern and fished opportunistically throughout the entire area.

A steep rise in fuel prices from about 12 cents to 48-50 cents a gallon in 1975 with associated inflationary prices of industrial products used by fishermen drastically changed the pattern of fishing.

These events restricted the fleets to fish only off their respective countries (a complete exclusion of Brazilian waters from the fishery in 1978 and 1979), to practice more efficient fishing with less travel, to relocate portions of their fleet within the fishery, to sell an entire fleet in some instances, to withdraw from the fishery in other instances, and to try to negotiate joint ventures with Brazilians. The number of U.S. vessels in this fishery decreased from 1974 to 1978 (Table 2).

U.S. Research Activity

United States research on the shrimp fishery off the Guianas and Brazil is aimed at providing assistance to our shrimp industries in the form of guidelines for proper management of the fishery.

Under the terms of the United States-Brazil Bilateral Fishery Agreement, we began to collect catch and effort statistics in 1972 from our vessels that fished in the Agreement Area. The entire data were submitted each month to the SUDEPE, Programa de Pesquisa e Desenvolvimento Pesqueiro do Brasil, the Brazilian equivalent of NMFS (National Marine Fisheries Service). We also collected catch and effort statistics from our fishing fleet off the three Guianas. Catch and effort data collected from 13 statistical zones (Fig. 1), were recorded by boat captains on a logbook form designed by us. This form found wide acceptance in Surinam, French Guiana, and Guyana for their data collection.

To learn more about the species distribution of shrimp, their biology, and associated fauna and ecology of the area, we conducted, from 1972 to 1978, six research surveys of the area with the NMFS fisheries research vessel *Oregon II*.

In 1976, we also initiated a port sampling program of shrimp landings to obtain more detailed biological data on species levels, which were not available from captains' logbook forms and landings statistics.

The international character of the Guianas-Brazil shrimp fishery required a continuous liaison between participating countries. This liaison was chiefly in the form of periodic scientific conferences between the researchers of participating countries and members of the shrimp industry. Perhaps the most significant conference on this fishery was held in April 1979 in Panama City, Panama. Although this workshop was sponsored by the international project known as the Inter-regional Project for the Development of Fisheries in Western Central Atlantic (WECAF), U.S. participation in terms of people and contribution of reports clearly dominated this meeting. Our entire data base from this fishery, representing a period from 1972 to 1978, was presented at this meeting.

At the beginning of our research activity, there was little information on this fishery, and most of it was scattered and fragmented. This report is primarily concerned with U.S. catch and effort statistics for 1975-77 but also includes other data for a more complete presentation of this fishery. The following sections of this report include condensed, salient features of accomplishments of our research.

Species Composition and Geographic Distribution, With Comments on Their Biology and Ecology

The geographic distribution of the four species indicates definite patterns. Brown shrimp, the most abundant species, occurs throughout the fishery, being most common off Brazil and French Guiana. Pink-spotted shrimp is the second ranking species, occurring throughout the fishery but most abundant off Surinam and Guyana. Pink shrimp is third with verified records only off Guyana, Surinam, and the western part of French Guiana. The fishable populations (chiefly adult forms) of these three species are found mainly from 15 to 45 fm (27-82 m). White shrimp occur along the shallow portion (<37 m or 20 fm) of this fishery and are the least abundant.

In our *Oregon II* surveys of the continental slope, we found commercial concentrations of scarlet prawn, *Plesiopenaeus edwardsianus*, at 350-450 fm (640-823 m).

Based on observed depth ranges and on frequency of occurrence at different salinities, the adult forms of brown, pink, and pink-spotted shrimp may be considered as eulittoral and sublittoral marine organisms. The white shrimp may be defined as eulittoral, euryhaline organisms. The scarlet prawns may be considered as archibenthic, stenohaline organisms.

In landing records, all species are reported together according to nine size (number/pound) categories (>50; 46-50; 41-45; 36-40; 31-35; 26-30; 21-25; 15-20; and <15/pound). Similar to the observation for the 1972-74 period, the majority of shrimp landed by the U.S. fleet during 1975-77 were in the size categories 21-25, 26-30, and 31-35 counts/pound. The size data indicate a trend by the U.S. fleet and by the Japanese fleet in landing progressively more shrimp in the small size categories (>50 and 41-50) during the past few years.

The size of shrimp in landings may represent a true picture on size availability but in some instances may also reflect selective forms of fishing as influenced by market price of shrimp, fuel prices, feasibility of operation, skill of the crew, and condition of the boat.

Similar to the 1972-74 observations, data for 1975-77 indicated a prevalence of small sizes in March 1975 and 1976 and April 1977. The largest sizes were in January, November, and December 1975 and 1976; intermediate sizes occurred during the summer months. The monthly peak of small size shrimp in March and April might be indicative of seasonal recruitment. Spatially, the largest sizes of brown, pink-spotted, and pink shrimp in 1975-76 were noted off Surinam and off eastern French Guiana.

Both Brazilian and U.S. data provide information on occurrence of juvenile brown shrimp. Brazilian reports state that juvenile brown shrimp are taken throughout the year by the artisanal shrimp fishery in Maranhao-Para, Brazil. Our data also indicate that small brown shrimp predominate in the catches off Amapa, Brazil, and eastern French Guiana, especially in March and April. A second area of occurrence of small brown shrimp is off Guyana. These observations may suggest that young shrimp are being recruited onto the fishing grounds principally for these areas. Based on information from the Surinamese Division of Fisheries, the juveniles of pink-spotted shrimp were identified in the estuarine Surinamese waters from April to June. Additional field work is required to delineate a precise spatial distribution of various sizes of shrimp.

Our Georgetown port sampling yielded information on sizes, sex ratios, and occurrence of four maturity stages of females on the species level. As in other shrimp populations, United States and Brazilian studies have shown that female brown, pink-spotted, and pink shrimp in this fishery reach larger sizes than males. The sex ratio for brown shrimp in 1976 was 1:1; in 1977 and 1978 the males outnumbered females by 2:1 and 3:1. For pink-spotted shrimp, males outnumbered females for all 3 years as the ratio progressively increased from 1.6:1 to 3.1:1 from 1976 to 1978. In 1976, male pink shrimp outnumbered females 1.6:1; in 1977 and 1978 the sex ratio was about 1:1 for both years. In white shrimp the sex ratio was about 1:1 for the 3 years.

The data on temporal occurrence of maturity stages of four species of shrimp showed irregular peaks. For proper interpretation of these peaks of abundance, additional work in the area of sampling will be necessary. The four maturity stages from I to IV indicated immature, maturing, mature, and spent condition of their gonads. All four stages of maturity for each species occurred during each month of the year, indicating year-round spawning. In 1976, all maturity stages of brown shrimp occurred each month during the entire period of observation (June-December); in 1977 stages I and II made up the bulk of samples, stage III was less numerous than stages I and II, and stage IV consisted each month of a few specimens. In 1978, stages I and II completely dominated the samples, while stages III and IV were poorly represented. The occurrence of maturity stages of pink-spotted shrimp for 1976 and 1977 lacked a pattern. In 1978, stage I of pink-spotted shrimp made up the bulk of this species. The occurrence of maturity stages of pink and white shrimp exhibited a lack of pattern.

Annual and Monthly Landings

The maximum U.S. catch of 13.6 million pounds was attained in 1973. In 1974, our catch dropped to 9.0 million pounds; in 1975 and 1976 it decreased to 6.8 and 5.9 million pounds; and in 1977 it increased to 8.2 million pounds. United States landings represented 49.8, 38.9, 35.2, 30.4, and 37.6 percent of the total international landings for 1973, 1974, 1975, 1976, and 1977. The maximum number of U.S. vessels (207) was reached in 1974 after a record harvest in 1973. During 1975, 1976, and 1977 a decline in the number of boats of 24, 35, and 32 percent was experienced. Except for 1972 and 1974, the mean annual catch of U.S. vessels was higher than the corresponding values for foreign boats combined (Fig. 2).

The monthly distributions of U.S.

landings from processing plant records and logbooks for the Guianas and Brazilian waters showed higher catches from March to July than during the remaining months of the year (Fig. 3). The mean hourly catch rates indicated higher catches during the first half of the year than during the second (Table 3). Off Brazil the catch rate for 1976 was 47 percent more during the first half than during the second, indicating that penaeids were more available to fishermen during the January-June period than the July-August period.

Catch Per Unit of Effort (CPUE)

In this report I use the mean annual catch per boat and catch per hour of actual fishing as methods of expressing CPUE. The mean annual catch rates for U.S. vessels in thousand of pounds were 72.3, 43.5, 43.4, 44.2, and 58.6 for 1973 through 1977. The highest monthly catch rates for the 3 years reported here were off Brazil (Fig. 4, 5).

The distributions of mean hourly catch rates and fishing effort of all species combined for 10 depth intervals are shown in Figures 6 and 7. The distribution of hourly catch rates for 1975 varied slightly throughout all zones and depths fished. Most of the catch rates were within the 10-30 pounds category. During 1976 the highest catch rates were off French Guiana and Brazil at depths of 20.1-36.6 m (11-20 fm). The catch rates for Brazil were higher for all fishing depths than those off Guyana, Surinam, and western French Guiana. The catch rates off Guyana, Surinam, and a part of French Guiana (zones 75 and 76) were fairly uniform. During 1977 the highest catch rates were off French Guiana and Surinam at 11.0-36.6 m (6-20 fm) depths; off Brazil high catch rates (21.0 pounds) were obtained for the entire depth range fished; off Guyana the catch rates varied slightly over the entire depth range.

Most of the effort for the entire fishery was concentrated at intermediate depths, between 36.6 and 64.0 m (21 and 35 fm)—53 percent for 1975, 59.1 percent for 1974, and 55.9 percent for 1977 (Table 4). At depths <36 m (<20 fm), the fishing effort was 25.8 percent, 18 percent, and 14.9 percent for 1975, 1976, and 1977; at depths >64 m (>35 fm), the effort was 20.8 percent, 22.7 percent, and 29.3 percent for 1975, 1976, and 1977. The distribution of fishing effort at 10 selected depth intervals indicated a geographic pattern (Fig. 7). Off Guyana (zones 69-71) most of the fishing was between 20.1 and 54.9 m (11 and 30 fm), off Surinam (zones 72-74) and French Guiana (zones 75-77) the fishing effort was between 29.3 and 82.3 m (16 and

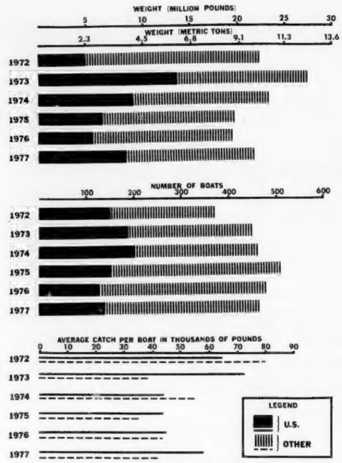


Figure 2.—Yearly landings of shrimp (heads-off weight), average number of active boats, and average catch per boat for the Guianas-Brazil fishery (1972-77).

Table 3.—Mean catch of headless shrimp per hour of trawling by U.S. flag vessels of the Guianas-Brazil fishery, 1972-77. For statistical zones, see Figure 1.

	Zones 69-77		Zones 78-81		All zones	
Year	lb	kg	lb	kg	lb	kg
1972						
Jan.-June						
July-Dec.	19.09	8.7	22.16	10.0	20.00	9.1
Jan.-Dec.					[1]24.34	[1]11.0
1973						
Jan.-June	23.29	10.6	33.41	15.2	28.10	12.7
July-Dec.	19.83	9.0	27.05	12.3	23.67	10.7
Jan.-Dec.	21.35	9.7	31.38	14.2	25.92	11.8
1974						
Jan.-June	20.01	9.1	22.40	10.2	20.96	9.5
July-Dec.	13.89	6.3	17.52	7.9	15.22	6.9
Jan.-Dec.	17.01	7.7	20.12	9.1	18.55	8.4
1975						
Jan.-June	14.82	6.7	17.65	8.0	15.82	7.2
July-Dec.	10.46	4.7	15.86	7.2	11.87	5.4
Jan.-Dec.	12.58	5.7	16.88	7.7	13.83	6.3
1976						
Jan.-June	13.88	6.3	24.33	11.0	18.59	8.4
July-Dec.	9.48	4.3	12.95	5.9	10.63	4.8
Jan.-Dec.	11.82	5.4	20.31	9.2	15.23	6.9
1977						
Jan.-June	7.82	3.5	28.83	13.1	19.71	8.9
July-Dec.	10.21	4.6	16.18	7.3	12.40	5.6
Jan.-Dec.	9.57	4.3	22.14	10.0	15.07	6.8

[1] Estimated values.

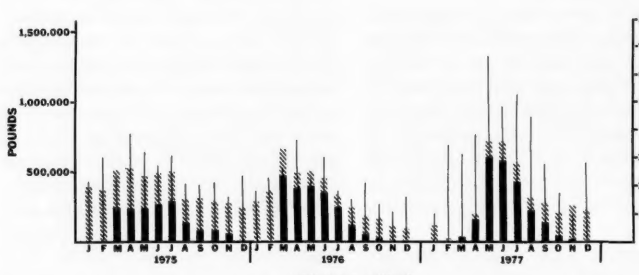


Figure 3.—Monthly shrimp catches (heads-off weight) of U.S. vessels by area for the Guianas-Brazil fishery. Vertical lines represent the total U.S. landings reported by the processing plants and are given by months in which the landings were made. Vertical bars represent the "haul" on estimated catches of U.S. vessels submitting logbooks and are reported by months of capture. The shaded area of the vertical bar represents the portion of the logged catches recorded from the U.S.-Brazil Shrimp Agreement Area.

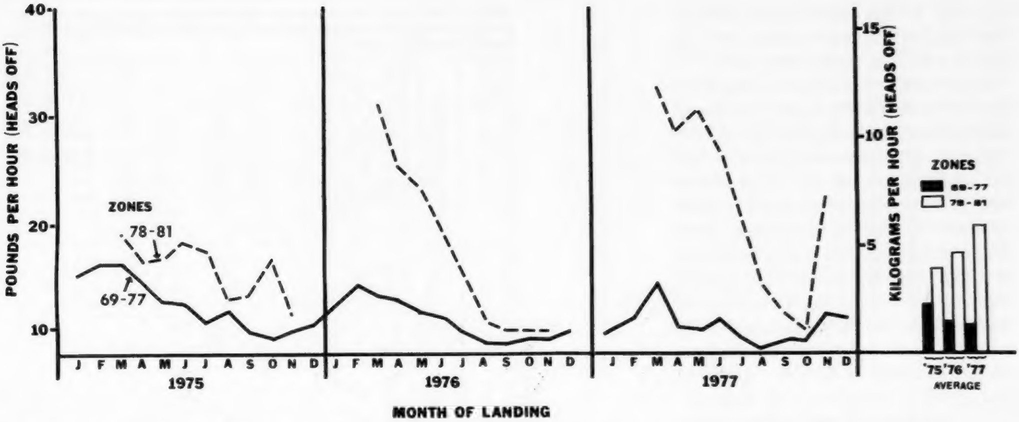


Figure 4.—Monthly distribution of the mean catch rates of shrimp (heads-off weight) for U.S. vessels fishing off the Guianas (zones 69-81), 1975-77.

45 fm), and off Brazil it was in deeper water.

Distribution of Catch and Effort in Relation to Day and Night Fishing

For the entire fishery, the average time spent night fishing was 2.8 times more than day fishing. The data on the time of day or night spent in fishing also showed the existence of areal differences (Fig. 8). Off Guyana, Surinam, and a large portion of French Guiana (zones 75 and 76), most of the fishing was at night. Except for East Gullies (zone 79) off Brazil, the reported fishing effort off French Guiana (zone 77) and off Brazil (zones 78, 80, and 81) was on a 24 hour per day basis in more

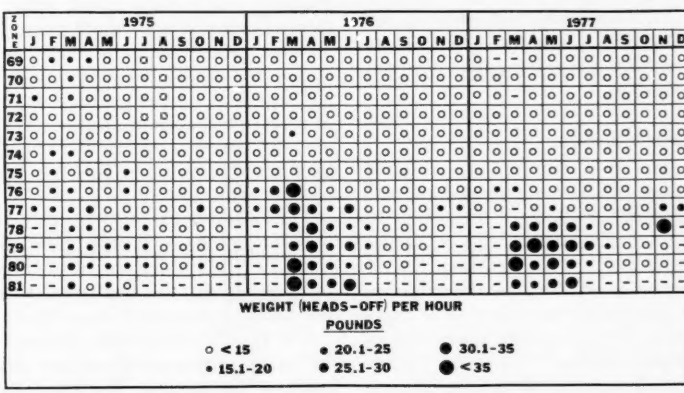


Figure 5.—Mean monthly U.S. catch rates of shrimp (heads-off weight) according to statistical zones for the Guianas-Brazil fishery, 1975-77. See Figure 1 for location of fishing zones.

Table 4.—Distribution of fishing effort in the Guianas-Brazil fishery (zones 69-81) 1975-77 expressed as hours fished, according to several depth intervals.

Item	Depth intervals in meters and fathoms											
	11 m 6 fm	11-18.3 6-10	20.1-27.4 11-15	29.3-36.6 16-20	38.4-45.7 21-25	47.5-54.9 26-30	56.7-64.0 31-35	65.8-73.2 36-40	75.0-82.3 41-45	84.1-109.7 46-60	Total	Percent
1975												
Hours fished	10,879	8,614	48,492	21,326	63,875	72,773	47,936	31,427	33,918	6,760	346,000	40.2
Percent	3.1	2.5	14.0	6.2	18.5	21.0	13.8	9.1	9.8	1.9		
1976												
Hours fished	7,857	3,860	29,084	9,798	61,108	57,880	46,367	21,087	34,392	8,173	279,606	32.5
Percent	2.8	1.4	10.4	3.5	21.8	20.7	16.6	7.5	12.3	2.9		
1977												
Hours fished	8,264	1,530	14,434	10,169	53,484	48,577	29,683	23,270	38,681	7,100	235,192	27.3
Percent	3.5	1.0	6.1	4.3	22.7	20.6	12.6	9.9	16.4	3.0		

than half of the observations. In the East Gullies, a large portion of the fishing was done during daytime.

Mean hourly catch rates of day fishing were considerably higher than those obtained at night throughout the fishery (Table 5). Examination of plots of day and night catches on the species level indicated existence of areal and diurnal differences. All four species were caught during day and night, but not in all zones. Brown shrimp were caught during day and night in all zones; pink shrimp were caught primarily during the night in all zones with the highest catches in zones 78-80 (West Gullies, East Gullies, and Drop Off Ridges). During the daytime pink shrimp were caught only in zones 69-71, 76-79, and 80. Pink-spotted shrimp were caught at night in all zones, except zone 81; daytime catches of pink-spotted shrimp were recorded in most zones (except 74, 75, and 81), with the highest catches in zones 74, 76, and 77; catch rates were much higher during the day than at night.

Table 5.—Mean hourly catch rates of shrimp for day (D), night (N), and both day and night (B) of fishing in the fishing zones of the Guianas-Brazil fishery. Units are in pounds.

	1975			1976			1977		
Zone	D	N	B	D	N	B	D	N	B
60	18.2	11.8	11.7	14.8	10.1	9.5	12.9	10.3	9.3
70	17.7	11.3	10.8	13.5	10.2	9.0	20.7	9.5	9.8
71	16.6	11.3	10.2	14.1	9.7	8.7	13.9	9.2	8.0
72	15.3	11.1	10.7	15.7	9.3	10.6		8.9	8.5
73	13.8	12.1	13.3	11.2	10.9	9.8	8.5	9.8	8.4
74	18.3	12.5	13.6	12.5	10.0	10.3	19.4	9.4	8.4
75	17.6	12.4	19.3	15.0	10.3	13.4	20.6	10.0	12.7
76	17.9	13.5	15.4	18.8	11.2	21.8	18.6	11.4	12.2
77	19.0	13.8	16.6	16.8	12.7	16.8	14.8	14.8	12.0
78	17.7	14.2	13.5	20.4	17.8	14.5	26.3	26.2	18.4
79	20.9	15.0	15.5	25.0	18.5	16.5	31.8	24.4	21.7
80	19.9	17.6	16.2	24.1	21.8	22.4	27.7	22.5	21.4
81	17.0	21.3	20.4	33.0	31.6	26.1	22.8	25.9	24.7

Stock Evaluation

Even though there are perhaps several fishable stocks of shrimp in the Guianas-Brazil fishery, data are needed to substantiate this supposition. For the purpose of assessing general trends we are considering this fishery to be represented by one fishable stock with all species combined. Based on catches from all operating fleets the conclusion on stock evaluation, as reached at the last WECAF meeting (April 1979), is presented here.

The period from 1960 to 1965 can be considered as the expansion period for this fishery. From 1965 onward the nominal commercial landings from the offshore Brazil-Guianas area remained fairly level from 15,000 to 20,000 t whole weight as the number of vessels varied from 350 to 650 (Table 1). A plot diagram of the number of vessels and the recorded catch indicates that the overall catch has not decreased in recent years parallel to the increase in fleet size and that the total catch can be maintained at the 1978 level (15,000 t) or perhaps increased slightly with a considerable increase in fleet size over the 1978 level (Fig. 9). These statistics do not account for: 1) Possible future environmental changes of the adjacent estuaries which could effect recruitment of penaeids to offshore areas; 2) possible overfishing of juveniles, resulting in a depressed yield per recruit and thus decreased long-term yield; or 3) concomitant changes in areal abundance of shrimp on species level which may have been offset by changing patterns in areal fishing.

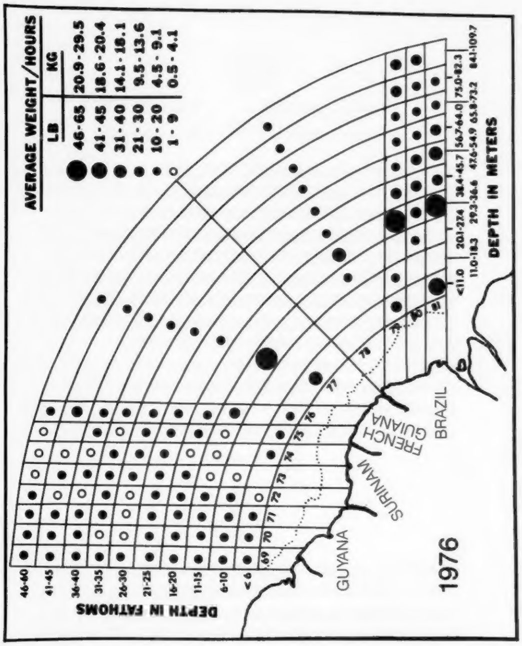
The statistics of several national and area-specific fleets portray different trends (Fig. 10), which may be partially attributed to the fact that these fleets fish different portions of the resource.

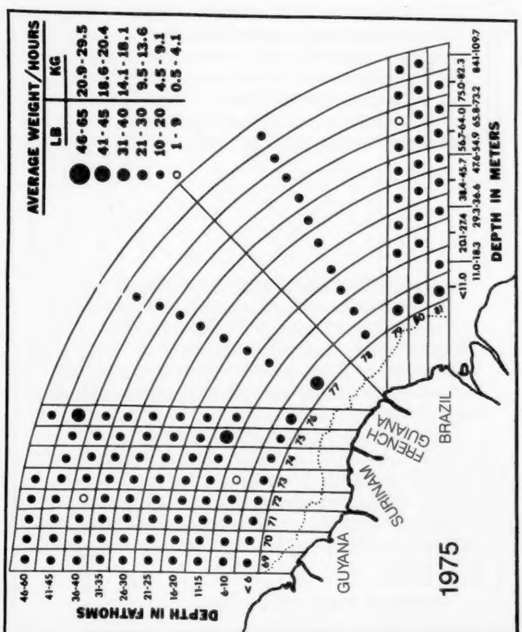
The Brazilian fleet fishes primarily for brown shrimp in the inshore area south of the Amazon River and the offshore area along the entire coast, north and south of the Amazon. From 1969 to 1973 the Brazilian-Belem fleet fished along the northern coast of Brazil; the number of vessels increased from 1 to 37 and vessel catch varied each day without evident trend (Fig. 10). Starting in 1974, in the area off Tutoia, located southeasterly of the Amazon, the Brazilian fleet located productive shrimp grounds and fished them, as well as the areas north of the Amazon. Catch per boat increased from 28 t in 1974 to 53 t in 1978, as the fleet size varied from 25 to 52 vessels. Catch per day also increased.

The Japanese fleet fished the entire offshore fishery and their catches were dominated by adult pink-spotted shrimp (80 percent). The catch per unit of effort generally decreased from 1966 onward (Fig. 10), even though the fleet fished different locations to prevent decline in catch rates. The long-term drop suggests a decline in the abundance of pink-spotted shrimp. Prior to 1977, the U.S. fleets based in French Guiana, Guyana, and Surinam fished the entire shelf off these countries for all four species of shrimp. Most of the catch was brown shrimp; pink-spotted shrimp was second (U.S. data). The overall drop in kilograms caught per day fished from French Guiana-based vessels concomitant with decreasing effort could reflect the drop in abundance of pink-spotted shrimp as indexed by the Japanese CPUE and a general gradual decrease in overall offshore abundance of brown shrimp. That trend is corroborated by catch per vessel abundance indices of Guyana and Surinam-based fleets (Fig. 10).

Data from the Brazilian, Japanese, and U.S. fleets on species level suggests a general decreasing trend in the abundance of pink-spotted shrimp and a general gradual decrease in overall abundance of brown shrimp.

At the WECAF meeting it was also realized that the estimates of MSY would not be very meaningful because there was lack of information on: 1) The inshore fishery of juveniles in nursery areas; 2) temporal changes in species composition of offshore catches during





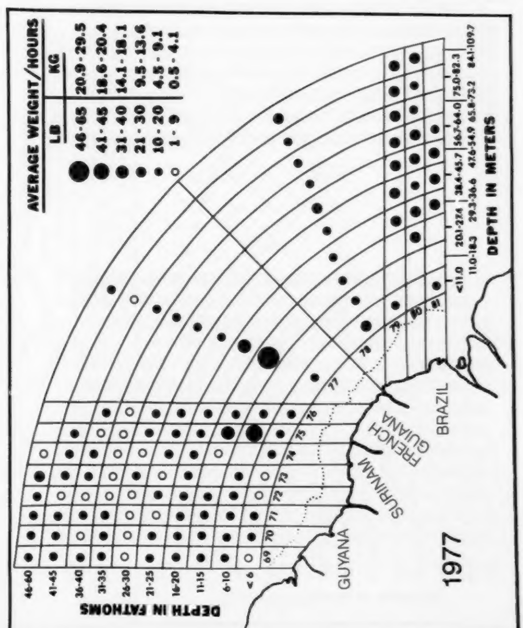
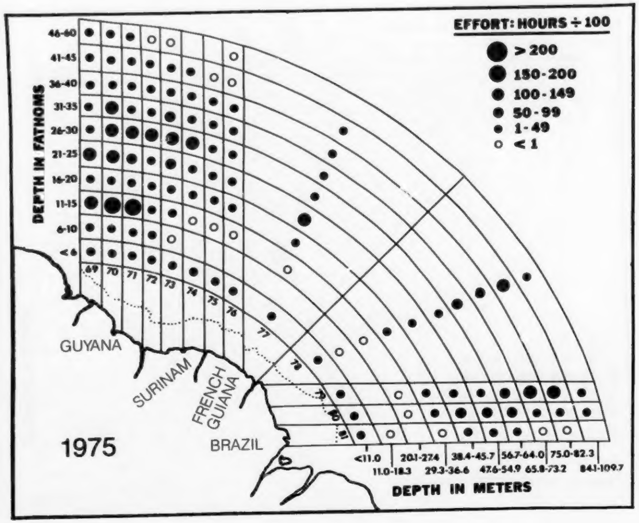
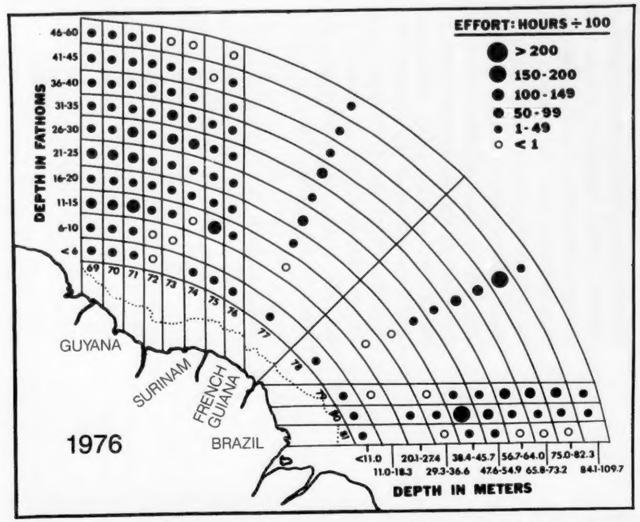


Figure 6.—Distribution of the mean hourly catch rates of shrimp (heads-off weight) by depth and fishing zone for the Guianas-Brazil fishery, 1975-77. The data are from U.S. vessel logbooks.

the period in question; and 3) species-directed effort necessary to develop accurate measures of CPUE indices of abundance for the species that are consistent throughout the time period. Gross statistics (Fig. 10) suggest that: 1) Total offshore catch declined from the maximum level of earlier years, 2) the 1978 catch level can be maintained at the current level of fishing effort, and 3) the total catch can probably be slightly increased over the 1978 level, with a moderate increase in fleet size. Statistics from





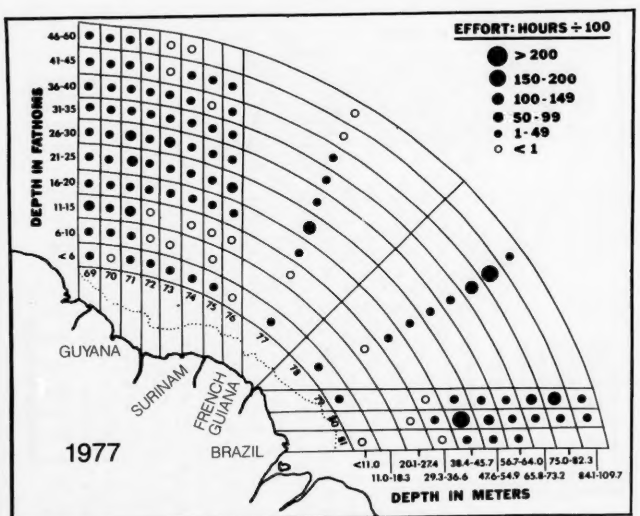


Figure 7.—Distribution of fishing efforts in the Guianas-Brazil fishery by fishing zone and water depth, 1975-77. The data are from U.S. vessel logbooks.

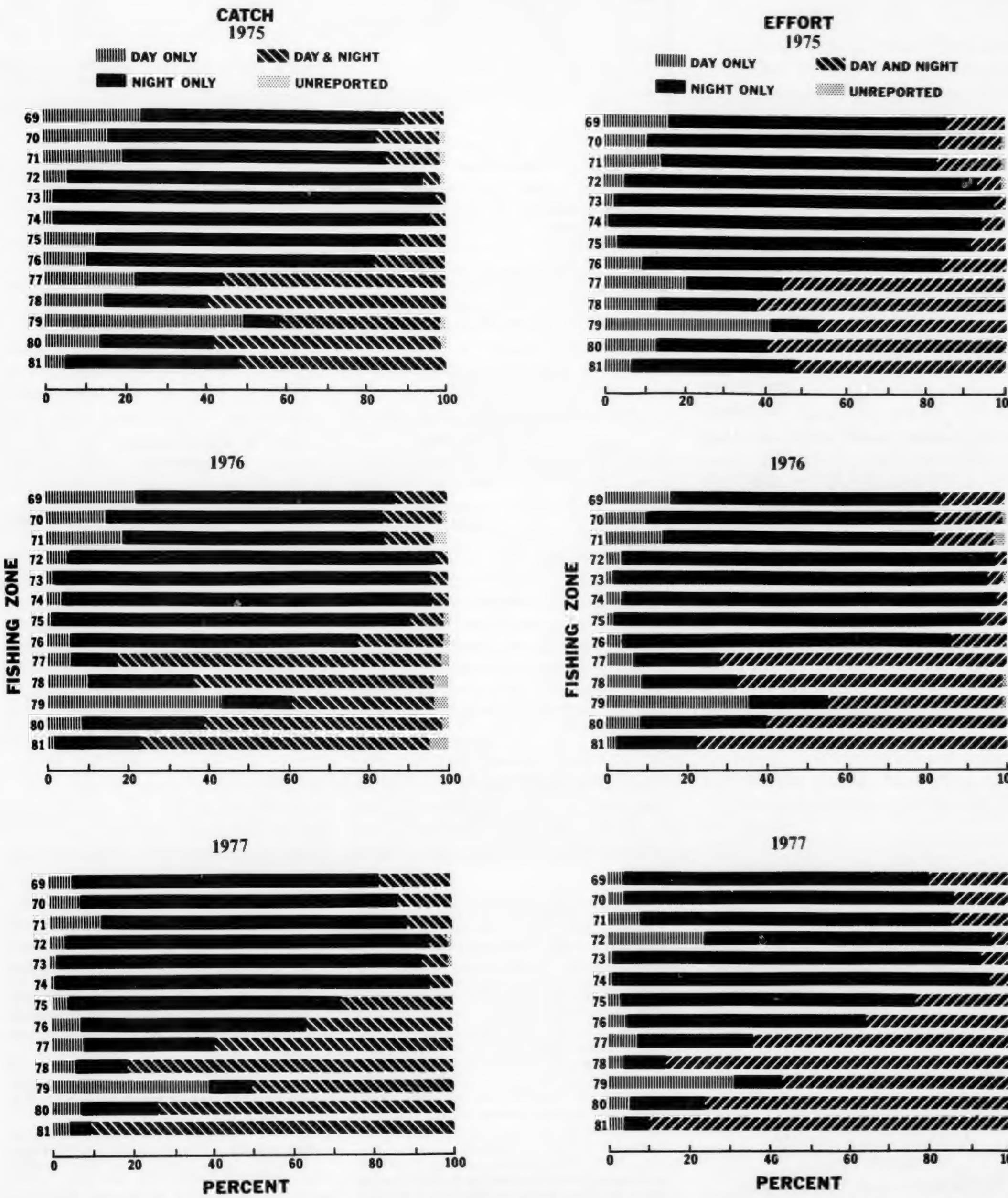


Figure 8.—Distribution of reported U.S. catch and effort (both expressed as percentage of the total) by the time of the day and fishing zone for the Guianas-Brazil fishery, 1975-77.

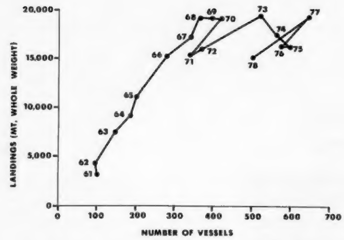


Figure 9.—Fleet size and offshore nominal catches of the Guianas-Brazil shrimp.

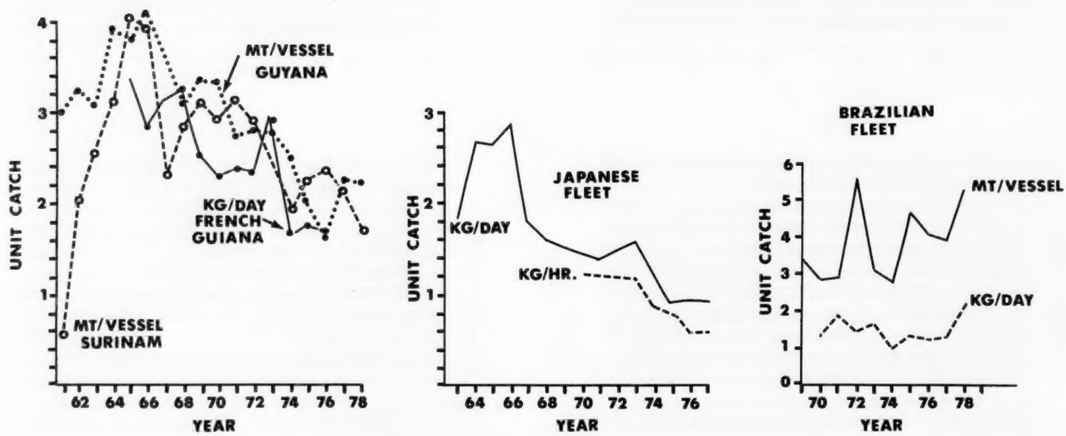


Figure 10.—Trends in catch per unit of effort by different fishing fleets.

individual national fisheries indicate: 1) The abundance of brown shrimp off Brazil has not decreased; 2) the abundance of pink-spotted shrimp off northern grounds (statistical areas 69-77) has decreased over the past few years; and 3) the abundance of brown shrimp off northern grounds (statistical areas 69-77) may have undergone a gradual decrease.

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Rope Culture of the Kelp *Laminaria groenlandica* in Alaska

ROBERT J. ELLIS and NATASHA I. CALVIN

Introduction

The brown seaweed or kelp, *Laminaria groenlandica*, which is abundant in the nearshore subtidal waters of southeastern and central Alaska, may have great potential for aquaculture. In Alaska, naturally occurring *L. groenlandica* is harvested in fisheries of Pacific herring, *Clupea harengus pallasi*, eggs on kelp in Prince William Sound. In British Columbia, *L. groenlandica* and another species of kelp, *Macrocystis integrifolia* (Fuoco, 1980), have been gathered and hung on ropes in ponds with spawning herring to produce herring eggs on kelp. *Laminaria groenlandica* is also a desirable sea vegetable having excellent texture and flavor in various cooked dishes. Similar species are commonly used in Japan and the U.S.S.R.

The use of naturally occurring *L. groenlandica* in herring-roe-on-kelp fisheries or as a vegetable has several disadvantages or limitations: 1) Collection requires much concentrated labor by divers, 2) continued collection poses threats to integrity of natural kelp forests (and herring stocks for roe on kelp), 3) natural kelp forests are limited in extent, and 4) kelp may be of poor quality when needed because of variations in condition of the plants due to age and seasonal changes. Techniques of rope culture have been developed for several seaweeds besides *L. groenlandica*, including other species of *Laminaria* (see Buyankina, 1977), but are intended for large-scale complex operations with seaweeds that have lower economic value than *L. groenlandica*.

As part of biological studies of naturally occurring kelp, we set out rope substrates and observed the *L. groenlandica* that set on the rope. This brief account of our experience could serve as a starting point for anyone interested in raising *L. groenlandica* on rope on a small scale in Alaska.

In this paper, we describe the placement of the ropes, time of first appearance of young *L. groenlandica*, size of the plants at various ages, and other life history features applicable to the use of rope for the culture of seaweeds in Alaska. Culturing of these plants results in more efficient use of labor and increased production of better quality *L. groenlandica* as a vegetable and for herring eggs on kelp. The rope system could be used to grow kelp in deep water by suspending the ropes from rafts and could greatly expand the kelp production in any bay. Additionally, portable substrates with "standardized" growths of young *Laminaria* could prove useful in studies of effects of pollution.

The general technique we describe for using rope as a substrate for raising *Laminaria* is simple. The ropes are seeded with young *Laminaria* by placing the ropes on the bottom near a kelp forest producing spores. The spores settle on the ropes, and eventually young *Laminaria* sporophytes develop. The young *Laminaria* soon attach firmly to the rope, which can then be moved to another site.

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Study Area

Our study area is about 17 km north of Juneau, Alaska, at Coghlan Island (Fig. 1) on a north-facing shore exposed to moderate wave action and currents (Calvin and Ellis, In press). At this site, small dense forests of *L. groenlandica* grow on rocky outcrops from about −1 m to −10 m depths on the eastern and western sides of a sand beach and subtidal area.

Methods

We used scuba to install two ropes as substrate on the sand within about 15 m of the kelp forest. The ropes were ⅝-inch (16 mm) diameter nylon; each was 25 m long and, though they had been previously used, appeared to be clean. Flat rocks about 4 m apart held the ropes on the bottom. The ropes were parallel to each other and about 10 cm apart. After the ropes were in place, four 1 m sections of the ropes were marked to represent the four depth zones encompassed by the rope — shallow (−2 m), deep (−8 m), and two intermediate zones (−4 m, −6 m). We installed the ropes in August 1974 and examined them intermittently through March 1980. The abundance and size of *L. groenlandica* were determined to follow survival, growth, and maturation of the plants. Measuring techniques are described in Calvin and Ellis (In press).

Appearance, Growth, and Size of Young-of-the-Year and Yearling Plants

Young-of-the-Year Plants

In February 1975, about 6 months after the ropes were installed, we first saw small, flat, nearly circular brown blades on the ropes. The plants were one to a few millimeters in diameter and emerged on short stipes from a layer of debris, silt, diatoms, and other small algae that covered the ropes. By October 1975, about a year after installation of the ropes, we could plainly see which plants were *Laminaria* though we could not be certain of the species.

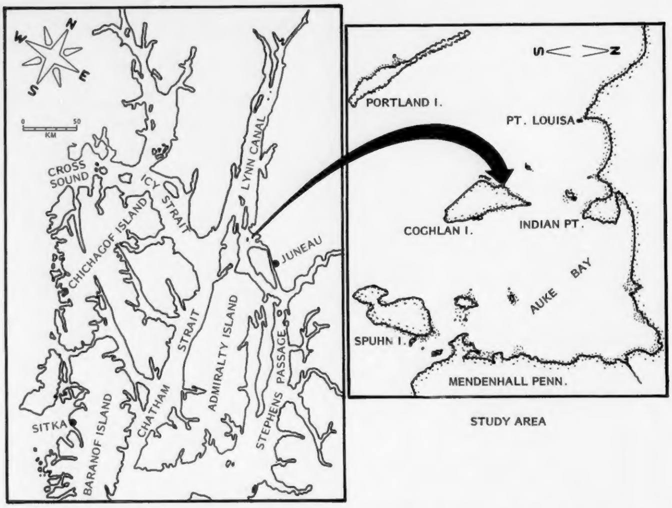

Figure 1.—Map of southeastern Alaska, showing location of kelp study area at Coghlan Island—17 km north of Juneau.

Table 1.—Dimensions, mean ($\bar{x}$), standard error of the mean ($S_{\bar{x}}$), and range of *Laminaria groenlandica* at the end of their first summer of growth (22 October 1975) over a depth range of −2 to −8 m on a rope substrate in southeastern Alaska. These plants were subjectively selected as typical of their depth area of the rope and were measured in the laboratory.

Sample (shallow to deep)	No. of plants measured	Stipe length (cm)			Blade length (cm)			Blade width (cm)		
		$\bar{x}$	$S_{\bar{x}}$	Range	$\bar{x}$	$S_{\bar{x}}$	Range	$\bar{x}$	$S_{\bar{x}}$	Range
1 (−2 m)	3	0.5	0.0882	0.4-0.7	5.3	0.9018	3.5-6.3	3.0	0.8413	1.3-4.0
2 (−4 m)	8	0.6	0.09150	0.1-1.0	5.2	1.0269	0.3-8.7	2.7	0.6213	0.2-6.3
3 (−6 m)	9	0.8	0.09923	0.3-1.2	4.8	1.0896	1.3-10.3	3.1	0.5034	0.5-5.8
4 (−8 m)	9	0.7	0.1054	0.3-1.0	6.6	1.0776	2.0-11.0	3.3	0.5398	1.2-5.3

Ultimately, we determined that all the *Laminaria* growing on the ropes were *L. groenlandica*.

On 22 October 1975, we collected *Laminaria* from the ropes and measured, in the laboratory, plants that appeared to be typical of the four depth zones of the ropes. At the end of the first season of growth, size varied greatly (Table 1), as expected, probably because of differences in age (original settling of spores could differ by many weeks) and microhabitats on the ropes. Nevertheless, the average sizes of *L. groenlandica* for the four areas of the rope were quite similar—average blade length, for example, was 5.3, 5.2, 4.8, and 6.0 cm (from shallow to the deep end of the ropes).

Yearling Plants

In late winter 1976, the plants were well into their second season (growth begins in midwinter) and were growing rapidly. The plants had survived well and were much closer together on the ropes than plants on the nearby reefs—as many as 200 plants/m were on the ropes where the largest plants were found. There appeared to be a positive relation between large numbers and large size of plants. These yearling plants were growing faster than mixed-age plants on the reef—whether this is a function of age or lack of general shading or competition from older plants is not known. We tagged many individual plants on the ropes in January 1976 and measured them (Fig. 2) on 13 April and 5 May 1976, about the time Pacific herring, *Clupea harengus pallasi*, spawn locally. The sizes of the five largest plants measured each date (Table 2) illustrate the potential sizes obtainable for the date and location. On 14 April 1976, we collected and weighed (wet weight) two large plants—the new growth on the larger plant (from −2 m) weighed 153.5 g (14.3 g stipe, 139.2 g blade) and on the smaller plant (from −3 m) 90.6 g (9.6 g stipe, 81.0 g blade). If growing conditions were improved—for example, by holding ropes off the bottom several meters to prevent plants from lying on the bottom; by placing the ropes in areas of more current; or perhaps with very heavy seeding, by thinning of plants on the ropes—more of the larger plants would be likely.

In May, the yearling plants were still growing rapidly and were clear of most epiphytic plants and animals. The rapidly growing, very smooth surface of the plants is desirable for use as a vegetable but may be a poor surface for adherence of herring eggs.

Conclusions

The procedures described here for growing *Laminaria groenlandica* on ropes are simple and require use of divers at only certain stages. The likely steps and considerations in establishing and using rope substrates for kelp production are:

1) A suitable site for seeding the ropes with young kelp plants should be within, or near and downcurrent from, a mature kelp forest.

2) Ropes should be well secured to the bottom in late summer, late in the spore-producing season of the kelp (midsummer to late fall in the vicinity of this study), to reduce competition from other organisms for settling space on the ropes. The depth the ropes

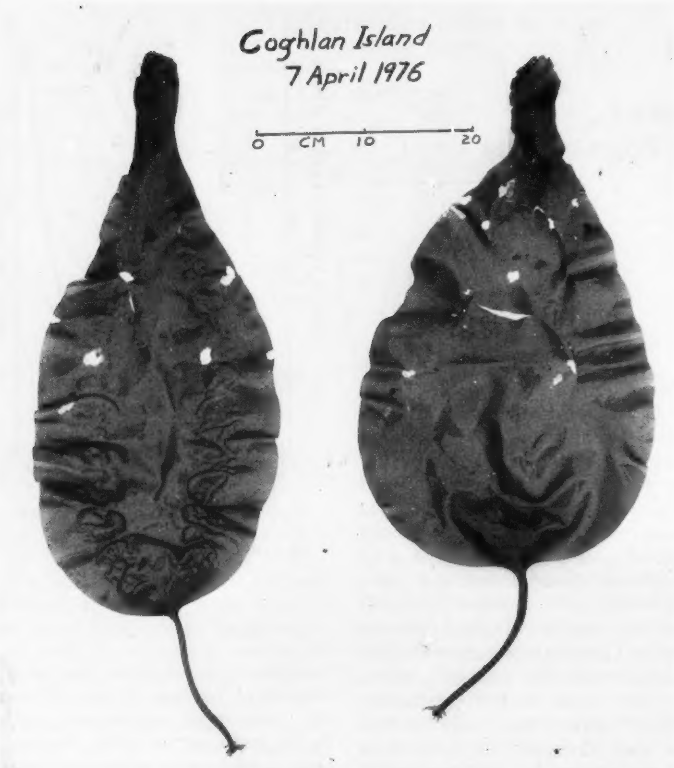

Figure 2.—Typical age 1 *Laminaria groenlandica* from rope substrate at Coghlan Island, 7 April 1976. These plants were growing very rapidly (about 1 cm/day). Pacific herring, *Clupea harengus pallasi*, spawn locally about the first of May.

should be placed for obtaining a seeding of plants is not critical but should be well within the depths occupied by the mature spore-producing plants. However, if the ropes are not to be moved until the kelp is harvested, the ropes should be at the depth of best growth locally.

3) The first spring or summer after the ropes are emplaced, divers should inspect the ropes to determine whether small kelp plants are present.

4) At the end of this first summer, the ropes can be moved to a culture site. The plants should be kept cool and moist with seawater while being moved and should be returned to the water as soon as possible.

5) For use as substrate for roe on kelp, the ropes could be moved to herring ponds at the beginning of the second summer. For use as a vegetable, the plants could be inspected periodically to determine when they are most suitable for harvesting. *Laminaria* cultured on ropes could be used for bioassay at almost any time after the young plants are large enough to be readily counted and measured.

6) Most, if not all, the operations in culturing *Laminaria* on ropes could be done from boats; however, many of the operations could be facilitated by divers.

Table 2.—Sizes of tagged yearling (age 1) *Laminaria groenlandica* on 13 April and 5 May 1976.

Tag	Length of stipe (cm)		Length of new blade (cm)		Width of new blade (cm)		Total length (cm)		Growth of blade length (cm/day)
	13 April	5 May	13 April	5 May	13 April	5 May	13 April	5 May	
Q	6	8	84	95	43	50	90	103	0.5
R	13.5	20	66.5	—	40	48	80	—	—
S	—	21	—	86	—	52	—	107	—
T	10	13	100	126	58	77	110	139	1.2
U	21	23	80	127	65	69	101	150	2.1
W	7.5	9	76.5	91	34	42	84	100	0.7

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The Impact of the Assurance of High Quality of Seafoods at Point of Sale

LOUIS J. RONSIVALLI, JOHN D. KAYLOR,
PHILIP J. McKAY, and CARMINE GORGA

Introduction

The need and the potential of assuring the quality of seafoods at point of sale have been adequately discussed (Nickerson and Ronsivalli, 1979; Ronsivalli et al., 1978; and Gorga et al., 1979). Although the high seafood sales demonstrated for both white-cloth and fast-service restaurants have been attributed to the high quality of the seafoods handled by these establishments, a clear relationship between assured quality and increased sales has not been evident because it has been difficult to separate the effect of high quality from the effect of the consumer not having to prepare seafoods.

Recent results, however, do show clear and positive effects of assured quality on sales both in the United States and in Australia. In the United States, one effort was conducted collaboratively between the National Marine Fisheries Service (NMFS) and elements of the U.S. seafood industry with the leadership and the bulk of the funding coming from the Government (Gorga et al., 1979). A second U.S. effort was conducted by Bashas[1], a small western supermarket chain (Zwiebach, 1978). In Australia, one effort was conducted by that country's largest supermarket chain, G. J. Coles and Company, Ltd. (Watson, 1979). In all cases, sales were increased significantly, going as high as 67 percent in one case.

[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

NMFS-Industry Effort

In 1975 NMFS technologists from the Gloucester Laboratory, Northeast Fisheries Center, and NMFS inspectors undertook a pilot collaborative effort with one seafood processor and six supermarkets from three different chains to explore the effect of assured seafood quality on sales. The pilot study, which lasted 2 years and cost a total of $200,000, included a $35,000 grant from the New England Fisheries Steering Committee and about $10,000 in in-kind services (use of processing plant, retail outlets, personnel, advisory services, etc.) from the Empire Fish Company of Gloucester and the supermarket chains of A&P, DeMoulas, and Stop & Shop. NMFS inspectors, whose role was initially on a fee basis, eventually also contributed significant in-kind services at numerous meetings that were devoted to logistics problems. The NMFS inspectors also assisted in data collection and made many important observations that led to the success of the project.

Except for the NMFS inspectors, who by design were to continue in their role, Federal involvement ended after the 2-year period, and the technology transfer from Federal laboratory to industry was complete. Even as this transition occurred, there was an expansion of industry efforts followed by a continuing accelerated growth. By the early part of 1980, the enterprise had grown to an annual volume of about 11,000,000 pounds worth nearly $30,000,000 per year (Fig. 1). The figure includes an additional 1,000,000 pounds of product sold annually which does not bear the U.S. Grade A label but which employs the same technological concepts used in the Government-inspected system. The number of processors grew from one to eleven, and the number of supermarkets grew from six to more than 1,100 located in at least 15 states and the District of Columbia (Fig. 2), representing about 40 percent of the total U.S. population. Figure 2 shows only the 10 plants that are under inspection. It is estimated that the size of the enterprise could be twice as large except for the lack of supply of U.S. Grade A quality fish fillets. The demand for assured quality has been found to be so persistent that less popular species like pollock and whiting are receiving a surprising acceptance by consumers when introduced under the assured quality program.

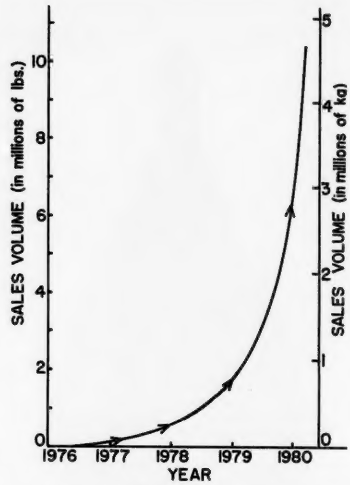

Figure 1.—Sales rates of fresh fish fillets carrying the U.S. Grade A sticker.

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Figure 2.—Locations of markets and plants involved in distribution of U.S. Grade A fresh fish fillets.

If a benefits-to-cost (B/C) analysis of this effort is based on the value of cumulative sales volume and government costs, we estimate its ratio to be more than 150:1. Since the government cost is a constant, the B/C ratio will continue to increase. In fact, as long as the sales rate is in an exponential growth trend, the B/C ratio will grow to exceptional levels in a short time. This analysis does not take into account multiple and other relevant economic factors which would increase the B/C ratio to a much higher level; nor does it reflect the intangible benefits that accrue to the consumer such as assured quality, opportunity to use more seafoods, improved dietary selections, etc.; nor the improved image that accrues to the seafood industry from gaining the confidence of consumers. Also, there are the indirect benefits that will have a favorable impact for the United States which experiences an annual seafood trade deficit of about $2 billion. If the domestic seafood industry can establish an image associated with high quality, there is the potential for capturing a larger share of the domestic market.

U.S. Industry Effort

The only other U.S. effort of which we are aware was conducted by a 26-store supermarket chain (Bashas) in Arizona (Zwiebach, 1978). This chain recognized the need to gain consumer confidence regarding quality. The high-quality, fresh seafoods created an impetus that spread to frozen seafoods, and the sales of seafood in the chain increased by about 67 percent. The biggest problem encountered by the chain was the limited supply available from the coastal producers from whom the product was received by air freight. Bashas found that the consumers were willing to pay a higher price for high-quality seafoods.

Australian Industry Effort

Approximately 2 years after the start of the NMFS-industry effort, an Australian firm, G. J. Coles and Company, Ltd., began a similar pilot effort in Melbourne. In less than 3 years, it spread throughout most of Australia, requiring the building of six processing plants to supply the demand that was subsequently generated (Watson, 1979). The Australian effort eventually was limited by the inadequacy of supply as were both U.S. efforts. However, unlike the large U.S. effort, the Australians were unable to introduce their underutilized species on the coattails of their high-quality conventional products. This appears to have been due to insurmountable organoleptic disadvantages of the Australian underutilized species that were not encountered in the U.S. effort.

Discussion and Recommendations

The three studies cited above should leave no doubt as to the beneficial impact of assuring the quality of seafoods at the point of sale. To add to these findings, a very recent New Zealand study concerned with the potential for increasing New Zealand's seafood exports to Japan concluded that it can depend on a large Japanese market only if it improves the quality of its product (Anonymous, 1979). (There is some evidence to show that the growth of the U.S. seafood export volume is also impeded by inferior quality of U.S. seafood products.) In another recent announcement, the president of the Fisheries Association of Newfoundland and Labrador has stated: "Quality enhancement is a key to the future of the industry, in both catching and processing. Without a major effort on quality, success in terms of the potential will not be achieved" (Wells, 1980).

There are two major problems which we believe require attention: 1) Lack of monitoring of product quality at most of the retail outlets and 2) inadequacy of supply. Although there was no stated concern in any of the efforts described above regarding the monitoring of quality at the retail outlets, it has been and still is a major concern of the authors. Even though the U.S. industry has assimilated the NMFS technology, it did not accept the entire recommendations. One of the NMFS recommendations was to maintain a monitoring capability at the retail level, and except for about 200 stores, this important recommendation has not been followed. What impact this laxity will have in the long run is not certain, but it does have the potential for eroding consumer confidence which is necessary for the program's success.

The problem of inadequate supply can be solved in a number of ways. Since high-quality products command a higher price, one solution is to provide for an economic incentive for fishermen. If fishermen are paid to

bring in more high-quality fish, they will do it. Quality maintenance aboard vessels requires adequate refrigeration (usually more ice) and undoubtedly more time-consuming handling. It is not in the financial interest of fishermen to increase their expenses without a higher return.

A second solution lies in the introduction of underutilized species. This is not difficult when the underutilized species meet certain selection criteria. For example, whiting fillets and pollock fillets, considered underutilized not too long ago, have enough desirable organoleptic qualities to have been accepted by many U.S. consumers. In cases where organoleptic characteristics are unfamiliar, the solution is obviously more complicated but by no means insoluble.

A third solution to the problem is to develop concepts for new products which can be made from underutilized species which do not appear to have marketing potential, and from the by-products of conventional species. For example, small fish, like sand lance, which are too small to process economically, and the "frames" from groundfish, which are a by-product of the process for producing fish fillets, can be deboned and used to produce a variety of new, precooked, ready-to-serve products.

Summary

The success of the three efforts described in this paper attests to the accuracy of the identification of a major problem common to the bulk of seafoods available to consumers in supermarkets and to the foresight and commitment of the management and personnel of the few companies cited above. The success of the NMFS-industry effort in particular is evident from the high benefits-to-cost ratio that has been achieved and from the fact that 5 years after its start, its growth is still in an exponential trend. All of this means that the potential for the domestic seafood industry is indeed very large. The smooth transfer of technology in that study was due to industry's clear understanding of its role from the very beginning and its agreement that the NMFS guidance held a high promise for success.

The extraordinary expansion of the idea of guaranteed U.S. Grade A quality is believed to be due to the NMFS stipulation that quality has to be assured throughout the chain of distribution up to and including the moment that it is purchased by the consumer.

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NOAA Awards $3 Million for Lost or Damaged Fishing Gear

United States fishermen collected more than $3 million in compensation during the past year for lost or damaged fishing gear caused by other vessels or extreme weather conditions, according to a report by the Commerce Department's National Oceanic and Atmospheric Administration (NOAA). Terry L. Leitzell, then NOAA's assistant administrator for fisheries, said $3.4 million had been paid to 603 claimants through 30 September under the Fishing Vessel and Gear Damage Compensation Fund.

The majority of the claims were for damage or loss caused by two instances of extreme weather and sea conditions. There were 477 claims totaling $724,160 paid for lobster and fish traps either damaged or destroyed by Hurricane David when it passed through the Virgin Islands and Puerto Rico last August.

Another 27 claims resulted from extensive damage to king and tanner crab pots caused by an unusual southward extension of the Bering Sea ice pack during January and February 1980. These claims totaled $1.7 million, and 24 more are pending. Forty-eight claims totaling $497,470 were paid for fishing gear damaged by foreign and domestic vessels. These claims were evenly divided between the east and west coasts.

About the Fund

The fund, established by an amendment to the Fishermen's Protective Act in September 1978, is administered by NOAA's National Marine Fisheries Service. It is used to compensate fishermen for fishing gear that is either lost or damaged by other vessels or extreme weather conditions. The amendment authorizes the Commerce Department to levy an annual 20 percent surcharge on the fees paid by foreign vessels for permits to fish within the 200-mile U.S. Fishery Conservation Zone. These revenues are placed in the compensation fund.

Most claims have been for the loss or damage of fixed fishing gear, generally traps or pots. Some claims of this type are not paid when the cause of the casualty cannot be established. In many cases, fishermen deploy fixed fishing gear and find it missing when they return. Since such gear casualties usually are not witnessed, their causes often cannot be ascertained. However, the program requires that the nature of a gear casualty be proven by a preponderance of the evidence. The exception to this rule is when two presumptions can be made about the casualties even though it was not witnessed.

The first presumption concerns other vessels. If eyewitness accounts or other evidence—either from the claimant, other persons, or governmental sources—establishes that vessel activity in the immediate area in which the claimant's gear was deployed was sufficient between the time the gear was placed there and the discovery of its damage or loss, then the casualty can be presumed to have been caused by the actions of another vessel and the claim may be eligible for compensation. Sometimes evidence associated with the remains of damaged gear establishes the cause of the casualty as the action of another vessel.

The second presumption involves acts of God. Weather and sea conditions are presumed to be acts of God if they qualify under a statistical measure. They must be more severe than one standard deviation above the historical mean of conditions in the area, and during the season, of the casualty. This means that only the most severe 16.67 percent of all conditions qualify for the act of God presumption.

Claims

Every casualty claim is examined to determine if a claimant's negligence contributed to loss or damage to the gear. A comparative negligence standard is used which may result in the amount of a claim payment being either reduced or not paid at all.

All claims must include a nonreturnable filing fee of 1 percent of the lower of two estimates of replacement or repair cost and specific information and evidence about the casualty. Compensation is for the depreciated replacement cost of lost or unrepairable gear and for the repair cost of repairable gear. If the claim is approved, the recipient must pay an approval fee of 4 percent of the final award. The filing fee and the approval fee cannot exceed $1,000.

As of 30 June 1980, all claims have to be filed within 90 days of the discovery of the casualty. Fraudulent claims are punishable by fine and/or imprisonment. Additional information about this program and how to submit a claim under it may be obtained from the Financial Services division, National Marine Fisheries Service, Washington, DC 20235 (telephone 202-634-4688).

The Ahlstrom Library Goes to NMFS Southwest Center

During a brief ceremony last summer, Margaret D. Ahlstrom, widow of the fishery biologist, Elbert Halvor Ahlstrom, unveiled a small bronze plaque officially dedicating her husband's library at the NMFS Southwest Fisheries Center at La Jolla, Calif.

Ahlstrom's library was built during a distinguished career of 40 years with the National Marine Fisheries Service and its predecessor agencies and reflected his consuming interest in ichthyology, particularly the science of larval fish biology to which he devoted his entire professional life.

The Ahlstrom library includes more than 250 books, many of them rare and valuable volumes, 10,000 reprints, and a large collection of serials. In accepting the library for the Southwest Fisheries Center, Izadore Barrett, Center Director, said that Ahlstrom's gift demonstrated his love of science and his willingness to share his broad knowledge and ideas with his colleagues and students.

DOC Gold, Silver Medals Are Awarded

Commerce Department gold and silver medal award winners named late last year include three National Marine Fisheries Service scientists: John Hunter with the Southwest Fisheries Center's La Jolla Laboratory, La Jolla, Calif. (gold medal); Roland Wigley with the Northeast Fisheries Center in Woods Hole, Mass. (silver medal); and Michael Laurs, also with the La Jolla Laboratory (silver medal).

Hunter, a fishery biologist, was awarded the gold medal for his discovery of new biological principles regarding the ecology of marine fishes. He has been a pioneer in the science of fish behavior of some types of schooling fish such as sardines, anchovy, and herring, which are of great importance in filling the world's protein needs.

Silver medalist Wigley, a fishery biologist, was cited for his contribution to the development of New England's billion dollar fishing industry and the protection of the northwest Atlantic's sensitive environment. Wigley's studies of deep-sea red crabs and northern shrimp are credited with launching and sustaining those fisheries.

Laurs, a research oceanographer, was presented the silver medal for his contributions to tuna oceanography and leadership in implementing cooperative government-industry albacore tuna research. He is credited with combining significant scientific contributions to oceanography and tuna biology with outstanding leadership in promoting and implementing cooperative research programs with universities, state governments, and industry.

Other DOC Gold Medals were awarded to: Robert W. Knecht, director of NOAA's Office of Minerals and Energy, for his work as assistant administrator of NOAA's Office of Coastal Zone Management (1972-79); Ray H. Barnes, for outstanding work as the meteorologist-in-charge of the NWS office in Mobile, Alabama, during Hurricane Frederic; Rex J. Fleming, director of the Global Atmospheric Research Program, for outstanding leadership as director of U.S. participation during the recent 5-year Global Weather Experiment; Robert J.C. Burnash, hydrologist-in-charge of the Sacramento River Forecast Center, for outstanding contributions to the field of hydrology and data acquisition; Wallace K. Kanahele, an able bodied seaman aboard NOAA Ship *Surveyor*, for rescuing a fellow crewmember who fell overboard while the ship was tied up in San Francisco; and Robert D. Wildman, deputy director, Office of Sea Grant, for exceptional leadership and scientific management skills in support of the National Sea Grant College Program.

Other Silver medal award winners were: Phyllis A. Polland, meteorologist-in-charge of the Pensacola National Weather Service office, for outstanding work during Hurricane Frederic; Henry R. Frey for "distinguished national service to the people and Government of the United States while serving as Project Manager and Principal Investigator of the National Ocean Survey National Strategic Petroleum Reserve Support Project"; Chester C. Slama, for contributions to science and technology which have "contributed to the improved efficiency and effectiveness of the photogrammetric and geodetic operations of the National Ocean Survey"; Armor L. Lane, director of the Marine Minerals division, for outstanding performance in providing Federal direction to the developing technology of undersea mining; Thomas M. Kaneshige, supervisory physical scientist, Office of Research and Development, for valuable and unique contributions during the recent 5-year Global Weather Experiment; Ronald D. McPherson, research meteorologist, Atmospheric Analysis branch, National Meteorological Center, for leading the development of a global analysis forecast system by using numerical methods; Ronald E. Reap, NWS research meteorologist, for developing a 12- to 36-hour probability forecast that can be transmitted in graphic form daily through AFOS, the NWS Automation of Field Operations and Services system; Denzil R. Davis, Quincy, Fla., retired supervisory meteorologist, and Jerrel E. Hughes, electronics development technician, for their combined contribution to science and technology benefiting the U.S. agricultural industry; George M. Kush, hydrologist, NWS field office in San Antonio, Tex., for outstanding management of the hydrologic services program in south Texas; Bernard Zavos, for outstanding management of the NWS' Overseas Operational Program (OOPS) in developing nations of Latin America and the Caribbean; and Raymond L. Coldren, NESS electronics technician for making weather satellite imagery available to users of pictures from space.

Four additional silver medals were awarded to a group of NOAA employees who rescued an elderly woman last Spring from the Elizabeth River near the docks of the NOAA Atlantic Marine Center, Norfolk, Va. They are: Kenneth Holden II, Rollings Hills, Calif.; Merrit N. Welter, Norfolk, Va.; Thomas G. Russel, Catonsville, Md.; and Robert H. Maness, Redford, Va. Ronnie J. Alberty and Stanley L. Barnes, meteorologists, Environmental Research Laboratories, received silver medals for their outstanding work in organizing and carrying out a major research project to improve understanding of severe storms and regional weather, SESAME '79 (Severe Environmental Storms and Mesoscale Experiment).

Foreign Fishing Policies of Latin American Nations

Latin American countries have developed various systems to determine how fishery resources are made available to foreign fishermen and at what cost. While varying in detail, the Latin American regulations have exhibited a general desire to reduce foreign fishing, or at least benefit economically from it, and also a tendency to establish an allocation system which does not require sophisticated surveillance.

Fishing fees, for example, throughout the region are almost exclusively based on the easily determined size of the vessel, instead of the amount of fish caught which would be more complicated to determine. There are three basic patterns most commonly used by Latin American countries to make coastal resources available to foreign fishermen:

1) Sell licenses with fees based on the size of the vessel (Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Mexico, Nicaragua, Panama, and Peru).

2) Require foreign companies to form joint ventures with domestic companies (Argentina and Brazil).

3) Develop ad hoc policies upon receipt of individual requests from foreign fishermen (Cuba, Venezuela, and most small Caribbean island countries).

Licenses

The sale of licenses based on the size of the vessel has been the most common method used by Latin American countries to regulate foreign fishermen. Some countries have more complex systems. Uruguay, for example, doubles fees for factory trawlers and vessels with onboard refrigeration. License fees based on the size of the vessel or other easily observable characteristics have the advantage of being easy to enforce and can generate earnings for the coastal nation by using a resource which domestic fishermen would otherwise be unable to utilize.

Licensing procedures, fees, duration, special restrictions, and sanctions vary widely from country to country (Table 1). Countries using the licensing system are mostly along the Pacific coast and several have developed their regulations specifically for foreign tuna fishermen. Some countries (Chile[1] and Peru) have restrictive regulations for specific species. Most countries prohibit foreign fishermen from catching such high value shellfish as shrimp and lobster which are fished by domestic fishermen. Several countries (Costa Rica[2], Ecuador, Guatemala, and Peru) grant special benefits to foreign fishermen who land part of their catch in the licensing country or form local joint ventures[3]. One country (Guyana) has special licensing fees for foreign vessels which are based in Guyanese ports[4]. Other countries (Ecuador[5], El Salvador, and Uruguay) have created special coastal zones within their 200-mile zone where foreign fishermen are not allowed to fish. Some countries (Ecuador, Guatemala, and Uruguay) require foreign fishermen to appoint a local agent. It is also common practice in Latin America to require foreign fishermen to purchase registrations ("matriculas") before purchasing licenses. The regulations for registrations are detailed in Table 1.

Joint Ventures

Requiring foreign fishermen to form joint ventures with domestic companies has been a less common option, but has been adopted by two of the most important Latin American countries (Argentina[6] and Brazil) and a third country (Mexico[7]) appears to be moving in that direction. These countries tend to close their coastal waters to foreign fishermen whether or not they have the domestic capability to fully utilize the resource.

Argentina and Brazil excluded foreign fishermen from their 200-mile zones even though coastal stocks (demersal finfish species off southern Argentina and shrimp off northern Brazil) were only being lightly fished by domestic fishermen. Despite data which demonstrates that shrimp stocks in Mexican waters in the Gulf of Mexico are not being fully utilized by Mexican fishermen, Mexico has decided to terminate access to these stocks for foreign vessels. The joint venture policy is designed to use fishery resources to attract foreign partners which will give domestic companies the capability to initiate new or expand existing fisheries.

[1] Details on Chile's licensing procedures can be obtained by requesting IFR-80/2 from your local NMFS Statistics and Market News Office.

[2] Details on Costa Rica's licensing procedures can be obtained by requesting IFR-80/33 from your local NMFS Statistics and Market News Office.

[3] A few countries (Brazil, Mexico, and Uruguay) are more concerned about the impact of foreign landings on fish prices and prohibit foreign fishermen from landing fish unless specifically authorized.

[4] Details on Guyana's licensing regulations can be obtained by requesting IFR-77/235R from your local NMFS Statistics and Market News Office.

[5] Details on Ecuador's licensing system can be obtained by requesting IFR-76/59 from your local NMFS Statistics and Market News Office.

[6] Details on Argentina's use of joint ventures to develop the fishing industry can be obtained by requesting IFR-80/13 from your local NMFS Statistics and Market News Office.

[7] Mexico's tuna licensing regime is described in IFR-80/9R and 51. The purpose of these regulations may be at least partially to encourage U.S. tuna fishermen to consider transferring their vessels to Mexican flag registry and to form joint tuna companies with Mexican partners. After excluding U.S. and Cuban shrimp fishermen from the Mexican EEZ in 1979, Mexican officials have left some hope of possible participation in the shrimp fishery through joint ventures.

Table 1.—Latin American regulations (Pacific coast countries) for foreign fishermen, 1979-80.

		Licenses			Restrictions			
Country	Regis-tration	Cost	Duration	Applica-tion	Zone	Methods	Sanctions	Other
Chile		Initial $800 fee and subsequent payments of $60 per NRT[1] for 100-day renewal.	100 days	Submit to the Sub-secretariat for Fisheries.	None	None	Payment of fine equal to $120 per NRT.	Regulations described here apply only to foreign tuna fishermen.
Colombia		$2.20-4.45 (100-200 pesos[2])/vessel-GRT[3] for firms domiciled in Colombia; $44.60 (2,000 pesos)/GRT for foreign-based companies.	If domiciled in Colombia 1 year (and one ocean); otherwise 30 days (and one ocean).	Submit to the National Institute for the Devel-opment of Renewable Natural Resources.	None	Shrimp fishing tem-porarily banned; lobster fishing is regulated. Foreign nationals not legally domiciled in Colom-bia may fish only for tuna, live bait, and cetaceans.	Confiscation of catch, gear, and vessel.	
Costa Rica	$5/NRT if purchased in the year before use; $10/NRT if bought the year of use.	$30 for vessels up to 400 NRT; $60 for vessels over 400 NRT.	60 days	Submit to Costa Rican consulate in San Diego or Panama City or the Fisheries Office in Puntarenas.	None	Vessels using live bait or harpoons instead of nets granted 50% reduction.	First violation: Criminal penalties, confiscation of catch, $100 fine per vessel NRT. Second violation: Criminal penalties, confiscation of vessel, equipment, catch.	Regulations described here apply only to foreign tuna fishermen. Foreign vessels less than 400 tons which sell at least 100 tons of catch to domestic canneries are granted free extension of their licenses. Foreign vessels under contract to a domestic company are treated the same as Costa Rican-flag vessels.
Ecuador	$100, valid for 1 calen-dar year.	$80 per NRT.	1 trip of up to 50 days.	Submit to Directorate General of Fisheries or Ecuadorean consulates. Permission to fish can be gotten by radio.	60-mile zone reserved for Ecuadorean vessels only.	Explosives and poi-sons prohibited. Foreigners are not allowed to fish for lobster or shrimp.	Payment of fine equal to $120/NRT and confiscation of catch for first offense; increased for subsequent violations.	Foreign fishermen can obtain special treatment by signing association agreements with Ecuadorean canneries.
El Salvador[4]	Not available	Not available but will be based on NRT of vessel.	Not available	Submit to Department of Industrial Develop-ment and Control or from Sal-vadorean consulates.	12-mile zone reserved for vessels of companies at least 50% Salvordean owned. 12-60 mile zone reserved for vessels operated by companies domiciled in El Salvador.	Not available	Payment of fine equal to US$80 per NRT; possible further punitive action.	
Guatemala	Free	Access rights: US$500/month for all vessels in excess of 91 NRT[5].	10 years	Submit to Ministry of Agriculture.	None	Use of poisons and explosives prohibited. No licenses issued for Pacific shrimp fishing.	Payment of fine from $100 to $5,000 or the equivalent in confiscated catch and gear. Fines are doubled for a second violation.	Number of licensed vessels limited by coast and species. Pacific coast tuna licenses are limited to 10 vessels.
Honduras		No licensing regulations for the nation's small Pacific coast.			None	None		
Mexico		$55 (P/1,250) per vessel and $61 (P/1,350) per NRT.	60 days	Submit to Mexican Department of Fisheries.	None	None	Confiscation of catch plus fine of from $3,750 to $15,000.	Foreign fishing authorized only if Mexico determines there is a surplus in its 200-mile EEZ. Foreign tuna fishermen must have an accredited representa-tive in Mexico.
Nicaragua[6]		$10 for vessels up to 10 feet in length; $1 addi-tional for each foot in excess of 16 feet[7].	20 years[8]	Submit to the Nicaraguan Fisheries Institute, km 4½ Car-retera Sur, Managua.	None	Use of poisons and explosives prohibited.	Not available.	Fishing licenses are only issued to persons or corporations who have contracts with processing plants in Nicaragua. A free navi-gation permit must be obtained from the Marine Division, Ministry of Defense.

Table 1.—Continued.

Country	Regis- tration	Licenses			Restrictions		Sanctions	Other
		Cost	Duration	Applica- tion	Zone	Methods		
Panama[9]		US$30 per NRT.	6 months	Submit to the Marine Resources Office, Ministry of Commerce and Industry.	None	Use of poisons and explosives prohibited.	Foreign vessels are subject to fines of from $10,000 to $100,000; repeated violations may result in confiscation of the vessel.	Foreign fishermen must have an agent in Panama and purchase a navigation permit costing from $500 to $1,200 (depending on the vessel's GRT) as well as miscellaneous charges totaling about US$100.
Peru	US$1,000, valid for 1 calendar year.	US$80 per NRT.	100 days[10]	Submit to the Ministry of Fisheries or to Peruvian consulates.	None	Use of poisons and explosives prohibited. Foreigners not allowed to fish for anchovies.	Fines of up to $80 per NRT for first offense, larger fines for subsequent violations.	Foreign commercial fishing vessels must have an agent in Peru. Fishermen must also have an operating license which costs $370 (S/90,000).

[1] NRT = Net registered tons.
[2] Based on exchange rates as of 31 March 1980.
[3] GRT = Gross registered tons.
[4] License information based on dated information about draft law.
[5] A separate fee schedule exists for the Caribbean coast.
[6] The U.S. Embassy in Managua reported on 25 July 1980 that INPESCA has prepared new regulations for foreign fishermen, but had not yet released them. INPESCA officials stated that there were "substantial changes" in the new regulations, but provided no details.
[7] An exploitation tax must also be paid, but it can be waived under the Industrial Development Law. The government studied the possible revision of these fees in 1980.
[8] In addition, a fishing permit for each vessel must be obtained annually.
[9] Panamanian regulations are described in greater detail by IFR-80/60.
[10] Waived for foreign ships under contract to Peruvian companies and selling entire catch in Peru.

Sources: Reports from the U.S. Consulate General in Guayaquil and U.S. embassies in the above countries; Latin American government documents; and various press reports.

Ad Hoc Policies

Many countries in Latin America have not formulated specific procedures, principally because foreign fishing off their coasts is not extensive. These countries evaluate requests from foreign fishermen on an individual basis. Venezuela, for example, has licensed one U.S. vessel and signed an agreement with Denmark allowing Faroese fishermen to fish experimentally in the Venezuelan EEZ, hoping that this will lead to a joint venture[8]. Cuba has still not published its licensing regulations and as a result has not fully responded to a U.S. request to catch swordfish in its 200-mile zone.

The policies enforced by Latin American countries to regulate foreign fishermen have, in several cases, severely impacted the distant-water fishermen who once fished there. U.S. shrimp, lobster, and tuna fishermen, for example, have been adversely affected. In some cases the coastal country has restricted or terminated distant-water fishermen even though local fishermen could not utilize the resource themselves. In 1967, for example, the Soviet Union caught 670,000 t off Argentina. Even though Argentina subsequently declared a 200-mile zone and prevented distant-waters fishing, the total catch by Argentine fishermen had still not reached 600,000 t by 1979.

The policies restricting distant-water fishing, have been very popular politically throughout Latin America and have therefore been of some support to the Government in power. The economic impact on the coastal countries has also been generally positive:

1) They have in some cases generated hard currency earnings from an economic resource which domestic companies were not fully exploiting or in some cases not exploiting at all.

2) They have encouraged distant-water fishermen to either land fish in local ports or to form joint venture fishing companies; in both cases promoting the development of the local fishing industry.

3) They have prevented damage to fishery resources through uncontrolled foreign fishing. (Significant harm was done in the 1960's and 1970's to fishery resources off the coasts of the United States, Canada, and western and southern Africa countries by the failure of coastal countries and international commissions to implement adequate conservation regimes.)

Some observers are concerned that the insistence by Mexico and other Latin American coastal countries to manage tuna unilaterally and restrict distant-water fishing may eventually cause economic problems for the local fishermen as well as distant-water fishermen. There are great variations in the quantities of tuna which appear off various countries each year. A large tuna fleet will have difficulty operating profitably if restricted to the narrow confines of the waters off any single country. In addition, because tuna range over such a wide area, no one country is able to control fishing effort. Without an international body to regulate fishing effort, it may not be possible to limit catches so as not to damage tuna stocks and as a result the profitability of national tuna industries. (Source: IFR-80/141.)

[8] Venezuela's policy toward foreign fishermen is described in IFR-76/102 and 80/95. Copies can be obtained from your local NMFS Statistics and Market News Office.

A Wave-powered Boat?

Boats of up to 50 m in length, propelled by wave energy, might be the result of successful tests in the Ship's Model Tank in Trondheim, Norway, according to the Norwegian Information Service. This item, invented by

Norwegian electrical engineer Einar Jakobsen, may have considerable significance for some sectors of the fishing fleet, say experts at the Trondheim laboratory. Last summer, successful trials were carried out in the Oslofjord, where the invention was mounted on a 27-foot sailboat hull.

The system consists, in brief, of a moveable foil—a water wing—placed horizontally on an axis beneath the boat. This moves up and down in step with the movements of the boat in the waves, and it is reportedly more effective against wave direction than with it. Jakobsen intends to continue the tests to develop the system further before putting it on the market.

France, Canada Agree to End St. Lawrence Cod Take

Roméo LeBlanc, Canada's Minister of Fisheries and Oceans, and Mark MacGuigan, Secretary of State for External Affairs, have announced that agreement has been reached with France on the maximum annual cod catches French vessels will be permitted to take in the Gulf of St. Lawrence until 15 May 1986. Beyond that date, vessels from France will no longer be permitted to fish in the Gulf.

The Agreement reached on 3 October in Ottawa will limit French catches of Gulf-based cod stocks to an annual maximum of 20,500 t for the period 1981-86. This limit may be reduced if total allowable catch limits for the two Gulf-based cod stocks are reduced below current levels. However, this is not believed likely. The French limit for 1980 was 20,540 t and for 1979 was 20,675 t.

The Agreement also gives Canada the option to require the French vessels to take up to 8,500 t of their annual entitlement from the southern Gulf cod stock, with a view to sharing the burden of the French fishery equitably between Canadian fishermen who fish in the north and those who fish in the south.

"The 1972 Agreement was very unclear regarding quantification of French fishing rights up to 1986," MacGuigan said. "The 1980 Agreement settles that issue, and should contribute to the furtherance of the good relations we have with France."

LeBlanc pointed out that the Agreement ensures that further development of the Gulf cod stocks will be for the benefit of Canada. "The stocks are rebuilding," LeBlanc said, "and the evidence indicates that over the next 6 years we will have TAC's well above the 1980 levels of 75,000 t for the northern Gulf cod stock, and 54,000 t for the southern stock. The question of how much fish the French were entitled to catch in the Gulf has troubled us for a number of years. This issue has now been laid to rest. We can now turn our attention entirely to the management of our domestic fishery to ensure that equitable allocations are made to the different sectors and interests represented in the Canadian fleet."

Can Oil and Fish Mix? Two North Sea Reports

The amount of oil pollution in the North Sea has increased in recent years and is greatest in the areas close to the oil fields, according to a report from Norway's Continental Shelf Institute (IKU) on the basis of oil trawling in the North Sea in June 1979. Altogether, 24 tests were made and deposits of oil were found in 21 of these. The oil concentration was calculated at 0.4 mg/mi^2 sea surface. This is double the amount found in a similar investigation in 1975, notes the Norwegian Information Service.

The report says that the increase may be due to increased activity on the continental shelf, increased oil transports in the area, and increased ship traffic. Reservation is made for the possibility that the registered increase in pollution is not indicative of general conditions but that it may be due to special wind or current conditions, or to accidental circumstances at the time the tests were made. The report's conclusion is that the increase observed is probably due to a combination of several of these circumstances.

Meanwhile, the University of Aberdeen in Scotland has prepared a study assessing the loss of access to fishing grounds caused by offshore oil and gas installations in the North Sea. The study was prepared for the British Fishing Federation and the Scottish Fishermen's Federation. It may be of interest to individuals studying the impact of off-shore oil development on the U.S. fishing industry.

A copy of the report can be purchased for £10 (US$24.00) by ordering Research Report No. 1, "Loss of Access to Fishing Grounds Due to Oil and Gas Installations in the North Sea."

Orders should be addressed to: M. Rattray, Department of Political Economy, University of Aberdeen, Edward Wright Building, Dunbar Street, Old Aberdeen, Scotland, United Kingdom. Checks should accompany orders and be made payable to the University of Aberdeen.

Clarification

Two statements in Richard A. MacIntosh's article "The snail resource of the eastern Bering Sea and its fishery" (Mar. Fish. Rev. 42(5):15-20), which could give readers an erroneous impression, have been clarified by William G. Gordon, Director, NMFS Office of Resource Conservation and Management.

1) On page 18, (column 1, last paragraph) is a statement that certain vessels were given an allocation by the North Pacific Fishery Management Council. Actually, "Section 201(d) of the Fishery Conservation and Management Act of 1976 says that the Secretary of State, in cooperation with the Secretary of Commerce, shall determine the allocation among foreign nations of the total allowable level of foreign fishing."

2) On page 19 (column 2) is a reference to "...a preliminary management plan developed by NMFS is being used by the North Pacific Fishery Management Council to manage the fishery." Actually, "Section 201(g) of the Fishery Conservation and Management Act of 1976 provides that the Secretary of Commerce shall prepare a preliminary management plan, under certain circumstances, for a foreign fishery, and may prepare and promulgate interim regulations with respect to such preliminary plan. The snail fishery in question is still being managed under the preliminary management plan prepared by NMFS for the Secretary, first issued in February 1977 and most recently dealt with in December 1979 by setting the OY and TALFF for 1980. The regulations under this preliminary plan are of course the Secretary's regulations, under authority of Section 201(g)."

New NMFS Scientific Reports Published

The publications listed below may be obtained from either the Superintendent of Documents (address given at end of title paragraph on affected publications) or from D822, User Services Branch, Environmental Science Information Center, NOAA, Rockville, MD 20852. Writing to the agency prior to ordering is advisable to determine availability and price, where appropriate (prices may change and prepayment is required).

NOAA Technical Report NMFS Circular 431. Flescher, Donald D. **"Guide to some trawl-caught marine fishes from Maine to Cape Hatteras, North Carolina."** March 1980. 34 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Abstract

Fishes covered are those regularly caught during trawling operations. Similar shaped fishes are grouped together. On each page the written keys are connected by lines to the fish illustrations; consequently, technical terms in the keys are illustrated as they are used. Notes on the size and range of each fish are included.

NOAA Technical Report NMFS Circular 432. Yoshida, Howard O. **"Synopsis of biological data on bonitos of the genus *Sarda*."** May 1980. 50 p.

Abstract

Published and some unpublished information on the biology and resources of the three species of *Sarda*, *S. australis*, *S. chiliensis*, and *S. sarda*, are compiled, reviewed, and analyzed in the FAO species synopsis style.

NOAA Technical Report NMFS Circular 433. Setzler, Eileen M., Walter R. Boynton, Kathryn V. Wood, Henry H. Zion, Lawrence Lubbers, Nancy K. Mountford, Phyllis Frere, Luther Tucker, and Joseph A. Mihursky. **"Synopsis of biological data on striped bass, *Morone saxatilis* (Walbaum)."** June 1980. 69 p.

Abstract

This synopsis reviews literature on the taxonomy, morphology, distribution, life history, population, ecology, recreational and commercial harvest, and culture of the striped bass, *Morone saxatilis* (Walbaum).

The striped bass is an anadromous species distributed along the Atlantic coast from northern Florida to the St. Lawrence Estuary, Canada; along the Gulf of Mexico from western Florida to eastern Louisiana; and along the Pacific coast from Ensenada, Mexico, to British Columbia, Canada. Populations have been established in numerous inland reservoirs and lakes. Striped bass spawn from mid-February in Florida until June or July in Canadian waters, and from mid-March to late July in California waters. Spawning occurs at or near the surface in fresh or nearly fresh waters at temperatures from 10° to 23°C; peak spawning usually occurs between 15° and 20°C. Yolk-sac larvae (prolarvae) range from 2.0 to 3.7 mm TL (total length) at hatching. Larval feeding is usually initiated from 4 to 10 days after hatching. At about 13 mm TL, larval striped bass form small schools and move inshore; during their first summer, juvenile fish move downstream into higher salinity waters in many areas. Most estuarine stocks of striped bass along the Atlantic coast are involved in two types of migration: the upstream spring spawning migration and the offshore coastal migrations which apparently are not associated with spawning activity. Male striped bass reach sexual maturity at an earlier age than females; most males are mature in 2 yr and females in their fourth or fifth year.

On Managing the Whales

Publication of **"Conservation and Management of Whales,"** by K. Radway Allen, has been announced by the University of Washington Press, Seattle, WA 98195. The author is a member of the Scientific Committee of the International Whaling Commission. He was formerly chief of the Division of Fisheries and Oceanography at Cronulla, New South Wales, Australia.

Based on a series of lectures by the author at the University of Washington in 1978, the book outlines the main concepts and techniques which have gradually evolved in the study of whale populations and reviews their application to the management of whales.

The author briefly discusses the biology of whales and the history of whaling, as well as whale populations and the history of their regulation in chapters 1 and 2. The following four chapters examine population models; methods of estimating populations and vital parameters; problems and sources of error in the estimation of populations and vital parameters; and management strategies, risks, and alternatives.

The 120-page book is available from the publisher for $12.50.

Accidents and Safety On and In the Water

Marine safety has long been a NOAA concern. Several new reports on marine-related accidents shed more light on their circumstances and prevention and provide a basis for safer marine research, fishing, and recreation.

Surviving Hypothermia

Hypothermia has long been recognized as a serious threat to outdoor and maritime workers and recreationists. It is also believed to be a major factor in about one-third of all U.S. drownings. In addition, it claims hikers, mountaineers, and even urban residents and motorists caught in severe winter storms.

The study of hypothermia, and techniques to prevent or treat it is rapidly bearing fruit. In recent months, NOAA researchers have discovered that many "drowning victims" can be successfully resuscitated—some after being under water 20-30 minutes.

NOAA, of course, has been at the forefront in funding research into hypothermia problems and solutions. In January 1980 the University of Rhode Island hosted the first International Hypothermia Conference and Workshop which explored cold exposure problems in great depth.

With the proceedings of that important meeting temporarily in limbo, URI opted to produce xerographic copies of the reports and papers, plus a wide collection of additional supportive reports on hypothermia in a three-ring binder. The entire package, over 600 pages, is available postage paid for $25.00.

If costly, it is also important data. "The information presented is extremely important, up-to-date, and will help save lives," says Neil Ross, conference chairman. The articles range from basic knowledge about hypothermia and its prevention and treatment to highly technical and medical reports.

The notebook has two parts: 1) Technical papers (arranged alphabetically by author), and 2) miscellaneous articles. Reports from many of the world's leading medical researchers and experts on all aspects of accidental hypothermia are presented. The data is important to those who need it for research, education, or survival. The proceedings can be ordered from the URI Marine Advisory Service, Division of Marine Resources, University of Rhode Island, Narranganset, RI 02882.

Underwater Accidents

The National Underwater Accident Data Center (NUADC) at the University of Rhode Island has collected, investigated, and analyzed data on 1,372 underwater diving fatalities from 1970-78. The result is **"U.S. Underwater Diving Fatality Statistics, 1970-78,"** Rep. No. URI-SSR-80-13, available for $3.00 from NUADC, P.O. Box 68, Kingston, RI 02881.

The 40-page report provides a wealth of accident data by diver age, experience, pursuit, location, surroundings, cause of death, and more. Accident terms are defined and selected accidents are discussed and analyzed. Appendices include an "Underwater Accident Report Form" and "Autopsy Protocol for Victims of Scuba Diving Accidents." A list of additional references is also provided.

Report data shows that one of every three "occupational" diving fatalities involved either commercial fisheries ventures or scientific research by persons associated with an academic institution. Notably, scientific diving for paid consulting purposes was fatality free for the entire period. Not counting diving instruction and unspecified activities, spearfishing, abalone diving, and shell/lobster fishing accounted for about half the nonprofessional diving fatalities between 1970 and 1978.

To be most useful, of course, these data need a point of reference (i.e., how many persons were at risk). As it is, the reader has no way of knowing whether a fisheries scientist, abalone diver, or an underwater welder is most at risk—or why.

Lightning Summary

EDIS' National Climatic Center (NCC) has published a **"General Summary of Lightning, 1959-1979"** by Henry Vigansky of the center. It includes a narrative of unusual lightning-associated deaths and injuries, tables of occurrences by state for the year 1979, and nationwide statistics (by year) for the period 1959-1979.

Water and trees were most hazardous. During the 21-year period, 15 percent of the 2,210 recorded lightning victims in the United States were standing under trees. But another 12 percent of those killed were either boating, fishing, or swimming.

The year 1979 saw the fewest number of recorded deaths during the 21 years, 63. The greatest number occurred in 1963, when 210 people were reported killed by lightning. The greatest number of deaths from lightning in 1979 were recorded in Texas, where seven people were killed; during the 21-year period Florida, with 223 fatalities, led the list.

A magnetic tape has also been prepared containing lightning statistics for the period 1959-1979. The tape contains the date/time (year, month, day and hour), location (state and county), number of fatalities, number of injuries and estimated amount of property damage for each lightning-associated report appearing in the NCC's *Storm Data* publication. There are about 14,000 individual reports for the 21-year period.

Inquiries about the availability of the summary and tape should be addressed to Henry Vigansky, National Climatic Center, Federal Building, Asheville, NC 28801.

Aquatic Plants and their Control

Publication of **"Aquatic Plants, Lake Management, and Ecosystem Consequences of Lake Harvesting"** has been announced by the Institute for Environmental Studies, University of Wisconsin—Madison, 120 WARF Building, 610 Walnut, Madison, WI 53706. Edited by J. E. Breck, R. T. Prentki, and O. L. Loucks, it is available for $6.50, paid in advance. Microfiche copies are also available from NTIS, 5285 Port Royal Road, Springfield, VA 22161 for $3.50.

The report is divided into six sections: I, Macrophyte biology; II, nutrient loading and flux of phosphorus from sediment; III, effects of harvesting on the consumer community; IV, mechanical harvesting options; V, institutional settings; and VI, overview of the conference findings.

The 435-page report provides a good review of the current status and knowledge of macrophyte biology, harvest practices, nutrient cycling, and the institutional mechanisms for implementing treatments.

Editorial Guidelines for *Marine Fisheries Review*

Marine Fisheries Review publishes review articles, original research reports, significant progress reports, technical notes, and news articles on fisheries science, engineering, and economics, commercial and recreational fisheries, marine mammal studies, aquaculture, and U.S. and foreign fisheries developments. Emphasis, however, is on in-depth review articles and practical or applied aspects of marine fisheries rather than pure research.

Preferred paper length ranges from 4 to 12 printed pages (about 10-40 manuscript pages), although shorter and longer papers are sometimes accepted. Papers are normally printed within 4-6 months of acceptance. Publication is hastened when manuscripts conform to the following recommended guidelines.

The Manuscript

Submission of a manuscript to *Marine Fisheries Review* implies that the manuscript is the author's own work, has not been submitted for publication elsewhere, and is ready for publication as submitted. Commerce Department personnel should submit papers under completed NOAA Form 25-700.

Manuscripts must be typed (double-spaced) on high-quality white bond paper and submitted with two duplicate (but not carbon) copies. The complete manuscript normally includes a title page, a short abstract (if needed), text, literature citations, tables, figure legends, footnotes, and the figures. The title page should carry the title and the name, department, institution or other affiliation, and complete address (plus current address if different) of the author(s). Manuscript pages should be numbered and have 1½-inch margins on all sides. Running heads are not used. An "Acknowledgments" section, if needed, may be placed at the end of the text. Use of appendices is discouraged.

Abstract and Headings

Keep titles, heading, subheadings, and the abstract short and clear. Abstracts should be short (one-half page or less) and double-spaced. Paper titles should be no longer than 60 characters; a four- to five-word (40 to 45 characters) title is ideal. Use heads sparingly, if at all. Heads should contain only 2-5 words; do not stack heads of different sizes.

Style

In style, *Marine Fisheries Review* follows the "U.S. Government Printing Office Style Manual." Fish names follow the American Fisheries Society's Special Publication No. 6, "A List of Common and Scientific Names of Fishes from the United States and Canada," third edition, 1970. The "Merriam-Webster Third New International Dictionary" is used as the authority for correct spelling and word division. Only journal titles and scientific names (genera and species) should be italicized (underscored). Dates should be written as 3 November 1976. In text, literature is cited as Lynn and Reid (1968) or as (Lynn and Reid, 1968). Common abbreviations and symbols such as mm, m, g, ml, mg, and °C (without periods) may be used with numerals. Measurements are preferred in metric units; other equivalent units (i.e., fathoms, °F) may also be listed in parentheses.

Tables and Footnotes

Tables and footnotes should be typed separately and double-spaced. Tables should be numbered and referenced in text. Table headings and format should be consistent; do not use vertical rules.

Literature Citations

Title the list of references "Literature Citations" and include only published works or those actually in press. Citations must contain the complete title of the work, inclusive pagination, full journal title, the year and month and volume and issue numbers of the publication. Unpublished reports or manuscripts and personal communications must be footnoted. Include the title, author, pagination of the manuscript or report, and the address where it is on file. For personal communications, list the name, affiliation, and address of the communicator.

Citations should be double-spaced and listed alphabetically by the senior author's surname and initials. Co-authors should be listed by initials and surname. Where two or more citations have the same author(s), list them chronologically; where both author and year match on two or more, use lowercase alphabet to distinguish them (1969a, 1969b, 1969c, etc.).

Authors must double-check all literature cited; they alone are responsible for its accuracy.

Figures

All figures should be clearly identified with the author's name and figure number, if used. Figure legends should be brief and a copy may be taped to the back of the figure. Figures may or may not be numbered. Do not write on the back of photographs. Photographs should be black and white, 8- × 10- inches, sharply focused glossies of strong contrast. Potential cover photos are welcome but their return cannot be guaranteed. Magnification listed for photomicrographs must match the figure submitted (a scale bar may be preferred).

Line art should be drawn with black India ink on white paper. Design, symbols, and lettering should be neat, legible, and simple. Avoid freehand lettering and heavy lettering and shading that could fill in when the figure is reduced. Consider column and page sizes when designing figures.

Finally

First-rate, professional papers are neat, accurate, and complete. Authors should proofread the manuscript for typographical errors and double-check its contents and appearance before submission. Mail the manuscript flat, first-class mail, to: Editor, *Marine Fisheries Review*, Scientific Publications Office, National Marine Fisheries Service, NOAA, 1700 Westlake Ave., N., Room 336, Seattle, WA 98109.

The senior author will receive 50 reprints (no cover) of his paper free of charge and 100 free copies are supplied to his organization. Cost estimates for additional reprints can be supplied upon request.

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